United States Department of Agriculture

Forest Service

Medicine Bow – Routt National Forests & Thunder Basin National Grassland

Laramie, Wyoming

June 2018

Hydrology Report

Medicine Bow LaVA Project

Medicine Bow National Forest

Albany and Carbon Counties, Wyoming

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June 4, 2018

Date

NOTE: Effects analyses are to be conducted at the scope and scale appropriate for the affected resources. Disclosure of effects is to be done by Accounting Units to lend site-specificity to the analysis. Where possible, use charts and tables to display AU information; use narratives to describe general effects and to compare effects by AU.

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SUMMARY

This specialist report evaluates and documents the environmental impacts of the proposed Medicine Bow Landscape Vegetation Analysis Project (LaVA) and one action alternative on watershed resources.

Waters in the project area originate from high elevation forest and alpine areas and produce very high quality water to support multiple uses both on and off the Forest. Most waters are Class 2AB water, which are designated for aquatic life, fisheries, drinking water, recreation, wildlife, agriculture and scenic value uses. Many management activities on the Forest have the potential to affect the quality, quantity, or timing of streamflow, or the condition of wetlands and riparian areas. To maintain the state-decreed beneficial uses of water, this project has been designed to protect watershed condition through the use of best management practices (BMPs) as prescribed in the Watershed Conservation Practices handbook (FSH 2509.25).

The Equivalent Clearcut Area (ECA) and Watershed Condition Framework (WCF) assessment tools were used as indicators of watershed condition of sixth level watersheds within the project area. Existing ECA (a measure of basal area removal) levels above twenty-five percent were used to identify watersheds reaching levels that may have measureable increases in streamflow. The WCF class and indicators were used as analysis indicators to establish existing conditions, and to measure potential effects of the proposed action on watershed resources. Current sixth level watershed ECA levels range from zero to twenty percent in project area watersheds. The WCF classification rated most project area watersheds as fair - functioning at risk. More information on the assessment tools is presented in the affected environment section of this report.

If no action is taken to harvest timber as identified in the LaVA project, no degradation to water resources will occur (e.g. no timber harvest, temporary road construction) and recovery from past activities will continue. ECA levels will recover and assuming no future disturbance, the resulting ECA in project area subwatersheds would range from zero to fourteen percent by the year 2039, which relates to the 20 year timeframe for the LaVA project implementation.

If the LaVA Modified Proposed Action is implemented, impacts to water resources will occur (e.g. sedimentation from temporary road construction). The magnitude of these impacts is highly uncertain given the absence of spatial and temporal details of proposed treatments. To account for this limitation, the project has been designed to treat the maximum amount of acres possible in any watershed without exceeding the 25 percent ECA threshold established in the Regional Watershed Conservation Handbook (USDA, 2006). More information on the allowable disturbance per watershed is presented in the environmental consequences section of this report.

The Modified Proposed Action Alternative incorporates Best Management Practices (BMPs), Forest Plan Standard and Guidelines and project design criteria, thus minimizing potential adverse streams and wetland impacts from sedimentation. This analysis assumes that the appropriate design criteria would be used to minimize impacts and assumes that observed trends from past activities implemented during the first 14 years of the Forest Plan and BMP effectiveness monitoring would be similar for this project's proposed management activities. Assuming all actions included in the Modified Proposed Action Alternative occur, projections show that this alternative would result in water quality effects from up to 534 road-stream crossings from temporary road construction; up to 0.8 miles of temporary road construction through wetlands; up to 12 miles of temporary road construction in the Water Influence Zone; up to 1,534 acres of harvest in wetlands; and up to 16,874 acres of harvest in the Water Influence Zone. With effective implementation of design criteria, and Best Management Practices, direct, indirect and cumulative effects to water resources will be reduced.

REGULATORY FRAMEWORK

Federal Laws and Regulations

The Organic Administration Act of 1897 (16 USC 475) recognized watersheds as systems that have to be managed with care to sustain their hydrologic function.

Clean Water Act of 1977 - which was created to restore and maintain the chemical, physical and biological integrity of the Nation's waters. (Section 101(a)). Section 303(d) of the Clean Water Act requires states to identify waters that are not meeting water quality objectives and are at risk of not fully supporting their designated beneficial uses. These water bodies are called Water Quality Limited Segments. The Clean Water Act directs that where water quality is limited, state agencies develop total maximum daily load plans to improve water quality to support the beneficial uses of water. The most recent listing was approved for Wyoming in 2014. This information was reviewed in context of the project area boundary. Section 313 of the Act required the federal government to comply with all federal, state, and local requirements for water pollution control in the same manner and to the same extent as a non-governmental entity. Section 319 of the Act requires states to develop a management program for nonpoint source pollution control. As part of their nonpoint source program, the state of Wyoming has developed Best Management Practices (BMPs) for silviculture and related forest management activities.

The Safe Drinking Water Act - Amendments of 1996 (PL 104-182) provides the states with more resources and authority to enact the Safe Drinking Water Act of 1977 (42 USC 300f). This amendment directs the states to identify source areas for public water supplies that serve at least 25 people or 15 connections at least 60 days a year.

The Sustained Yield Forest Management Act of 1944 (16 USC 583) and the Multiple Use Sustained Yield Act of 1960 (16 USC 528-531) allow for the production of multiple quality goods and services at sustained levels over time, including maintenance of water supply.

The Forest and Rangeland Renewable Resources Planning Act of 1974, as amended (16 USC 1601-1614). Known as the Resource Planning Act (RPA), this act requires an assessment of present and potential productivity of the land. The act contains many references to suitability and capability of specific land areas, to maintenance of productivity of the land, and the need to protect and, where appropriate, improve the quality of the soil and water resources. The act specifies that substantial and permanent impairment of productivity must be avoided and has far-reaching implications for watershed management (including monitoring, inventories, condition and trends, and support services) on National Forests.

The National Forest Management Act of 1976 (NFMA) recognized the fundamental need to protect, and where appropriate improve, the quality of soil, water, and air resources.

The Endangered Species Act of 1973 (16 USC 1531-1536, 1538-1540) requires federal agencies to conserve threatened and endangered species and the ecosystems they depend on.

Executive Order 11990, 1977; (Wetlands Management) requires federal agencies to follow avoidance, mitigation, and preservation procedures with public input before proposing new construction in wetlands. To comply with Executive Order 11990, the federal agency would coordinate with the Army Corps of Engineers, under Section 404 of the Clean Water Act, and mitigate for impacts to wetland habitats.

Executive Order 11998, 1977; (Floodplain Management) requires all federal agencies to take actions to reduce the risk of flood loss, restore and preserve the natural and beneficial values in floodplains, and minimize the impacts of floods on human safety, health, and welfare.

State Laws and Regulations

The Watershed Conservation Practices (WCP) Handbook (FSH 2509.25) provides Management Measures as well as Design Criteria and meets the intent of the Wyoming Nonpoint Source Management Plan Silvicultural Best Management Practices (WYDEQ, 2004; USDA Forest Service, 2016).

Forest Service Direction

Regulations and policies have been passed in support of these laws and require:

1. Protection of surface resources and productivity from all natural resource management activities (CFR 219).

2. Watershed analysis as part of all planning activities (CFR 219 and FSM 2500).

3. Limitations of resource use to protect watershed condition. FSM 2500 and Forest Service Handbooks (FSH) 2500 state Forest Service policy and direction regarding watershed management.

4. Implementation of the National BMP Program to advance the Agency's compliance with management of nonpoint source pollution and address the new planning rule requirement for national BMPs (36 CFR 219.8(a)(4)). Monitoring BMPs is an integral component of the National BMP Program and is necessary to evaluate whether BMPs were implemented and whether the implementation of the BMPs was effective in protecting water quality.

Region 2 2006 Watershed Conservation Practices Handbook

The regional Watershed Conservation Practices (WCP) Handbook (FSH 2509.25) falls under the umbrella of the National Best Management Practices for Water Quality Management on National Forest System Lands (USDA Forest Service, 2012), and provides a more specific local direction to ensure that the chemical, physical, and biological integrity of watersheds is maintained. According to the WCP, streams and watersheds exhibiting the following conditions are considered to be at "potential" and can be defined as being in dynamic equilibrium:

Integrity of streamflow - Expressed as minimum flood runoff and maximum base flows. Healthy watersheds exhibit high rates of infiltration that result in minimum surface runoff. Most precipitation soaks into the soil, which tends to retard flooding, recharge ground water, maintain riparian and wetland areas, and regulate streamflow.

Integrity of the fluvial system - Expressed as stable stream networks and channels and a balance between runoff and sediment yield. In healthy watersheds, the stream network is not expanding

through gully erosion, streams are neither aggrading nor degrading, channel capacity is maintained over time, and streambanks are well vegetated.

Integrity of water quality and aquatic habitat - Healthy watersheds exhibit good stream health supporting productive, diverse, and stable populations of aquatic life and displaying a natural range of habitat features such as depth of pools, composition of substrate, and sequence of pools and riffles for the aquatic organisms.

The WCP Handbook (FSH 2509.25) contains management measures and design criteria to protect water quality in compliance with the Clean Water Act. The WCP standards address actions on National Forest System lands, including timber, range, water development, engineering, recreation, and all other actions that have the potential to affect water resources.

Forest Plan Direction

The Medicine Bow-Routt National Forests Thunder Basin National Grassland National Forest Land and Resource Management Plan (Forest Plan) (USDA Forest Service 2003) provides management direction and standards and guidelines for the vegetation management activities proposed in the Landscape Vegetation Analysis Project. The management direction is summarized in the environmental impact statement. The Forest Plan provides management direction based on water influence zones (WIZ), including standards and guidelines and riparian conservation objectives found in the environmental impact statement:

- Standard 3: Manage land treatments to maintain enough organic ground cover in each activity area to prevent harmful increased runoff.
- Standard 4: In the water influence zone next to perennial and intermittent streams, lakes, and wetlands, allow only those actions that maintain or improve long-term stream health and riparian ecosystem condition.
- Standard 15: In watersheds containing aquatic, wetland or riparian dependent TES species, allow activities and uses within 300 feet or the top of the inner gorge, (whichever is greater) of perennial and intermittent streams, wetlands and lakes (over ¼ acre) only if onsite analysis shows that long-term hydrologic and riparian function, channel stability, riparian and stream habitat will be maintained or improved.

ANALYSIS METHODOLOGY

Sources of information used to support this report include: BMP monitoring reports, local forest Geographic Information System (GIS) data including streams, waterbodies, and roads, and past, present, and reasonably foreseeable activities related to cumulative watershed effects.

Treatment Opportunity Areas have been identified. The overall levels of proposed activities have been defined at the project level; allocation of the type and intensity of treatment across the project area landscape will be guided by such things as the Forest Plan, compliance with the Southern Rockies Lynx

Amendment, and watershed conditions/ECA levels; units have not been delineated and currently are not proposed to be delineated until the implementation phase. The conditional NEPA challenge under this scenario is to provide a site-specific effects analysis, without actual treatments being delineated. The approach below provides one way to quantify likely proposed activity affects to water resources across the entire project area (e.g. wetland impacts across the project area), but does not address site-specific impacts to individual water resources within the project area.

Similar activities (harvest, roads) to those proposed in LaVA have been implemented over the life (2004-2017) of the existing Medicine Bow National Forest Land and Resource Management Plan (Forest Plan). These activities have been implemented under the existing Forest Plan Standards and Guidelines, the Watershed Conservation Practices handbook, and Project Design Criteria. LaVA will follow the same laws, regulations, and policy. While under a conditional NEPA approach, the process proposed in LaVA is different, the project design criteria, application of BMPs, specialist reviews are very similar to what has been implemented under the existing Forest Plan.

Spatial information is available for activities that have been implemented under the existing Forest Plan. Spatial water resources information is available. By overlaying various activities (e.g. roads/harvest) that have occurred with various water resource indicators (wetlands, water influence zone), the spatial extent of past activities in relationship to water resources can be quantified. This information can then be used to proportionally estimate the quantity of proposed activities, across the project area, in relationship to water resources. For example, if there have been 100 acres of past harvest and 15 acres of that harvest have occurred in the Water Influence Zone, and if 1000 acres of new harvest are proposed, then an estimated 150 acres of the proposed harvest can be assumed to be in the Water Influence Zone (15/100 : 150/1000) and the remaining 850 acres can be assumed to occur outside of the WIZ. Potential effects can then be discussed using the quantitative values for activities within and outside of the WIZ. These metrics or indicators can be considered the “most probable”, rather than “worst case”, scenario under full implementation of the LaVA proposed action as they are proportional projections based on actual activities that have occurred while implementing the current Forest Plan.

Metrics are presented for two timeframes. In order to provide a context for existing conditions, readily available data as far back in time as was readily available was utilized. For instance, harvest activities were considered from 1934 – 2017. In order to predict metrics for proposed/future activities, the analysis limits the timeframe to the current Forest Plan period (2004-2017), as the activities implemented during this timeframe are believed to be the best predictor of future activities, since the management plan and management direction are most similar to the current situation. Per the 11/15/17 Landscape Vegetation Analysis proposed action document, future activities are displayed over a 15-20 year implementation timeframe (2019-2039).

Analysis Assumptions for this approach includes:

- Harvest and road activity data are a reasonable representation of activities on the ground.
- Wetland/WIZ data are a reasonable representation of conditions on the ground.
- Activities implemented under the current Forest Plan from 2004-2017 are a reasonable predictor of how and where future activities will be implemented.

The Equivalent Clearcut Area (ECA) and Watershed Condition Framework (WCF) assessment tools were also used to establish baseline conditions, and displaying maximum allowable treatments from the proposed action. The Forest Service ECA procedure was designed to estimate streamflow responses to forest management in third to fifth order streams (King, 1989) corresponding to subwatersheds (HUC 6) of 10,000 to 40,000 acres (Ager and Clifton, 2005). ECA is used to assess the cumulative effects of vegetation treatments and roads by providing a broad indicator of changes in peak streamflows (Ager and Clifton, 2005). As literature suggests, watersheds approaching 25 percent of basal area removal may begin to experience increases in water yield (USDA, 2006; Troendle and Nankervis, 2000).

Spatial and Temporal Context for Effects Analysis

Effects analysis for this project considers direct, indirect and cumulative effects. Spatially, for these effects the context is the same, the boundaries of the 6th level watersheds where any treatments, roads or other project-associated activities would occur. This level of analysis was selected as it provides an adequate scale for determining potential effects. If a larger scale was used, the amount of area tends to dilute potential effects, and when smaller scales are used the amount of area is too limited in scope.

The temporal scope for watershed long term effects is based on the 80 year vegetative recovery used in the ECA cumulative effects analysis protocol. For short term effects, the temporal scope can range from hours up to one year post treatment, or the amount of time estimated for short term sediment related effects from this project to be no longer perceptible.

Resource Element and Indicators

Effects to water resources may include: changes in stream runoff and peak flows, sedimentation, and channel instability. Effects to water quality from roads and vegetation management in forested lands derive from the ground disturbance nature of associated management actions, resulting in loss of ground cover, compaction, and/or displacement. Sediment runoff from these is typically short in duration and mostly noticeable within the first year post treatment and/or after the first annual peak storm event.

Management actions resulting in a significant basal area loss, approximately 25 percent of a watershed area, may result in water flow regime and channel function alterations. The potential increase in water available for stream flow is due to decreases in interception and transpiration, and would be mostly noticeable after the first annual peak storm event post disturbance, but may take up to 80 years after implementation for vegetation to regrow and water yield to recover.

The effects of the LaVA project are evaluated using the following resource indicators which will be subsequently used as the basis for the effects analysis. A brief explanation on each one of these indicators is provided. This information is complemented in the affected environment and environmental consequences sections of this document.

Water Quality

The introduction of sediment into streams is a potential effect associated with mechanical vegetation treatments, prescribed burning, road maintenance, reconstruction and the construction and obliteration of temporary roads. Roads deliver a continuous input of sediment into adjacent streams and water bodies, the amount of which differ depending on road surfacing, volume of traffic, soil type and other factors. The road reconstruction and maintenance work, culvert cleaning and replacement along with increased traffic due to hauling from the proposed treatments, could potentially result in short-term increases in sediment delivery beyond normal levels into streams at their respective locations during project implementation. It is recognized that due to the increased road activity short term direct and indirect effects would be expected from roads within the WIZ and at stream crossings. These may include increased turbidity and suspended sediment values. Sedimentation may impact the immediate footprint of the road/stream crossing location and a short distance of channel downstream of the site, with effects diminishing further downstream. Most project-related sediment would likely mobilize during the initial year of disturbance and decrease over time.

There is general consensus, reported in conclusions on research, on the value of buffer strips of riparian vegetation along stream courses (Castelle et al. 1994, Bentrup, 2008). Buffer strips on streams and riparian areas act variously as sinks and filters for sediment, pesticides, certain pathogens and nutrient constituents such as nitrogen and phosphorus. Therefore the probability of sediment delivery to streams increases sharply when mechanical disturbance occurs within the Water Influence Zone (WIZ). The WIZ is defined as land next to water bodies where vegetation plays a major role in sustaining long-term integrity of aquatic systems. It includes the geomorphic floodplain (valley bottom), riparian ecosystem, and inner gorge. Its minimum horizontal width (from top of each bank) is 100 feet or the mean height of mature dominant late-seral vegetation, whichever is most. Projected quantities of harvest and road construction in the Water Influence Zone are used as indicators to display the potential effects of the proposed project (Gloss, 2018), along with implementation and effectiveness information on BMPs designed to minimize effects to water quality.

Water Quantity

Potential direct and indirect effects associated with vegetation treatments include a decrease in basal area and an associated increase in water available for stream flow and potential modifications to peak flow timing. The potential increase in water available for stream flow is due to decreases in interception and transpiration. The Equivalent Clearcut Area (ECA) process was used to establish baseline conditions, and disclose impacts of the proposed action from the reduction of vegetation cover. All known disturbances that occurred within the past 80 years and all reasonably foreseeable disturbances are included in the ECA analysis. There are limitations to this analysis, including: ECAs are only an indicator and cannot be used to estimate quantitative changes in stream channel conditions; the higher risk associated with near-stream disturbance (as opposed to disturbance far from any stream channel) is not factored into the analysis; the method does not account for site specific best management practices; and the method does not account for other watershed characteristics that influence overall watershed vulnerability to disturbance.

Table 1. Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure
Water Quality	Sedimentation – Direct Effect	Road-stream crossings (#)
Water Quality & Wetland	Sedimentation – Direct Effect	Road construction in wetland (miles)
Water Quality	Sedimentation – Indirect Effect	Road construction in water influence zone (miles)
Water Quality & Wetland	Sedimentation – Direct Effect	Harvest in wetland (acres)
Water Quality	Sedimentation – Indirect Effect	Harvest in water influence zone (acres)
Water Quantity	Water yield	Equivalent Clearcut Area (Percent basal area removed)

Although this analysis is conducted at the subwatershed scale (e.g. 6th level or 12 digit HUC), the effects analysis is conducted at the Accounting Unit level per Forest Supervisor's direction. Accounting units are much larger than the subwatersheds and do not necessarily correlate to subwatershed boundaries. Appendix D displays the environmental effects of the proposed action per Accounting Units.

AFFECTED ENVIRONMENT

Existing Condition

Water resources on the project area play a vital role in ecological sustainability both within and outside of the Forest boundary. Since the Forest is located at the northernmost end of the Laramie, Parks and Front Range mountain ranges, the landscape and water resources are significantly different than the arid high desert landscapes surrounding the Forest in southeastern Wyoming. These differences are apparent in both water quantity and quality and define how Forest water resources contribute to the ecological sustainability of the region.

The quantity and quality of water on the project area is significantly different than the surrounding landscape. The quantity of water generated from the Forest is significantly greater than the surrounding region in southeastern Wyoming. Annual precipitation on the Forest ranges from 14 to over 50 inches and comes predominately in the form of snow. In contrast, annual precipitation in the surrounding regions in Wyoming is less than 14 inches and is dominated by rainfall. These differences in precipitation result in a higher proportion of streamflow being generated from the Forest than surrounding areas. Water quality on the Forest is typical of mountainous regions of the area, but contrasts with the water quality of the surrounding lower elevation areas. Colder water temperatures, limited nutrients and low salinity are examples of differences in physical, biological and chemical properties of water on the Forest that are reflected in the how the water is put to beneficial use.

The relatively higher quantity and quality of water on the Forest is important to ecological sustainability both on and downstream of the Forest. Water resources on Forest provide unique aquatic habitats, such providing extensive habitat for coldwater fisheries, that is limited in other portions of southeastern Wyoming. In addition, much of the water generated on National Forest System lands is critical to sustaining ecological processes in and along the rivers leaving the Forest, in some cases as far downstream as the Platte River in Nebraska and the mainstem of the Colorado River in Utah.

General Watershed Condition

Forest Service Manual 2521.1 directs forests to establish watershed condition and assign a designated watershed condition class rating. The Forest has evaluated watershed conditions based on direction from the Watershed Condition Framework (USDA, Forest Service 2011a) and the Watershed Condition Classification Technical Guide (USDA Forest Service 2011b). Twelve core watershed condition indicators comprised of attributes (related to watershed processes) were assessed to classify watershed conditions. For a complete explanation of the condition rating rule set for the attributes, see the Watershed Condition Classification Technical Guide (USDA Forest Service 2011b).

Table 2. Watershed Condition Class Description

Watershed Condition Class (WCC)	**Watershed Condition Class Definition**
WCC I (Functioning properly - good)	Watersheds exhibit high geomorphic, hydrologic and biotic integrity relative to their natural potential condition. The drainage network is generally stable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are predominantly functional in terms of supporting beneficial uses.
WCC II (Functioning at risk - fair)	Watersheds exhibit moderate geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. Portions of the drainage network may be unstable. Physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems are at risk in being able to support beneficial uses.
WCC III (Impaired function - poor)	Watersheds exhibit low geomorphic, hydrologic, and biotic integrity relative to their natural potential condition. A majority of the drainage network may be unstable physical, chemical, and biologic conditions suggest that soil, aquatic, and riparian systems do not support beneficial uses.

The Watershed Condition Assessment Tracking Tool was queried May 17, 2018 to summarize the watershed condition class and indicators for subwatersheds within the project area. Figure 1 shows a

summary of the Watershed Condition Classes for subwatersheds within the LaVA project area. This assessment showed that 54 subwatersheds within the project area are rated “Functional at Risk” and 16 subwatersheds are rated “Functioning Properly”. There were no “Impaired” watersheds identified in the assessment. Overall watershed condition for the majority of watersheds in the project area is functioning with certain indicators at risk in being able to support beneficial uses. A more detailed analysis of relevant indicators is provided below under the water quality, quantity and environmental consequences sections of this report.

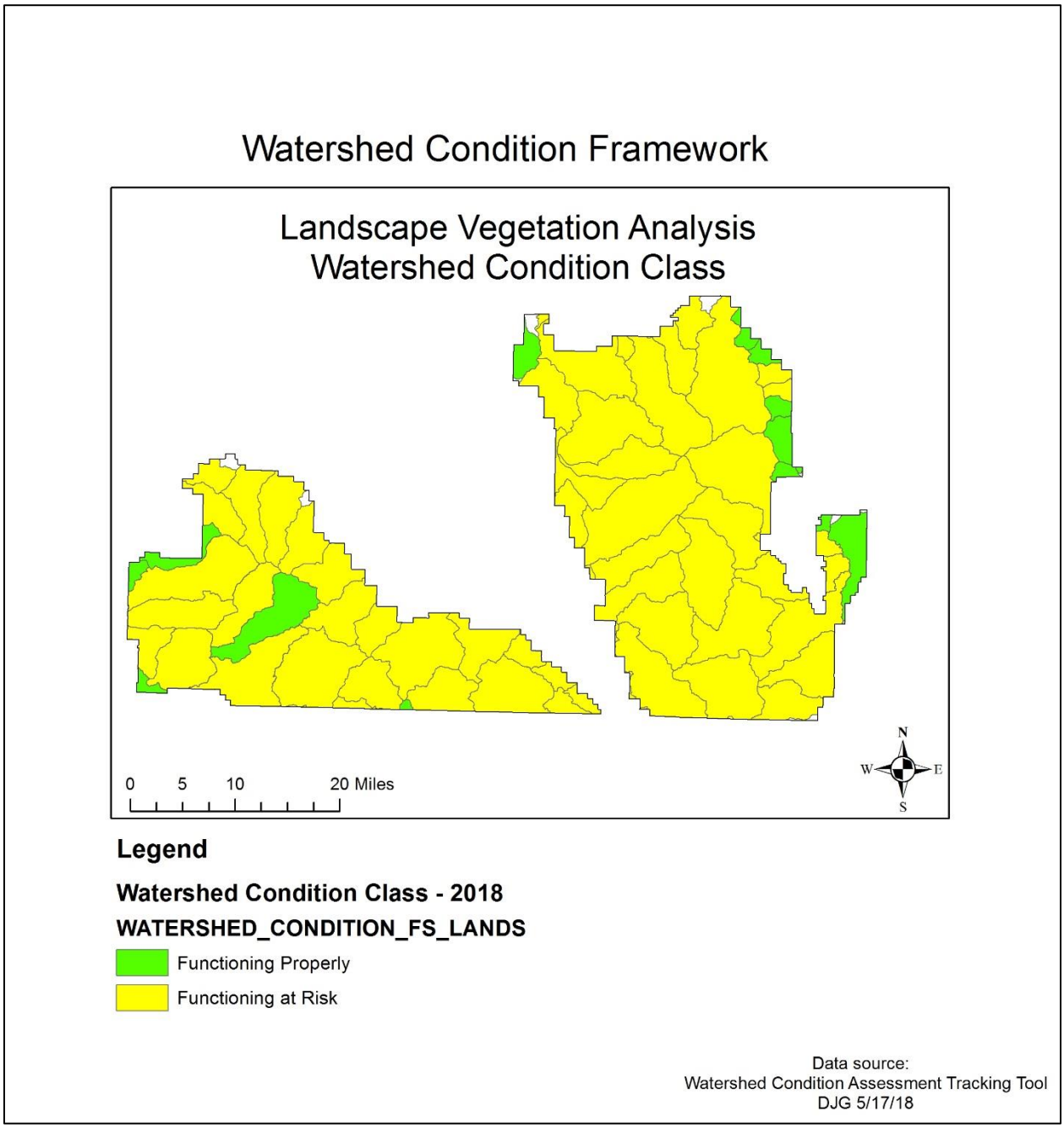

Figure 1. Overall Watershed Condition Classification.

Water Quality

All waterbodies on the Forest are designated either Class 1 or 2 by the Wyoming Department of Environmental Quality (WDEQ). According to Wyoming's draft 2016/2018 Integrated 305(b) and 303(d) Report (WDEQ 2018), five stream segments in the project area have "Impaired or Threatened" water quality due to heavy metals: 1) Roaring Fork Little Snake River (1.8 mi) , 2) Haggarty Creek (5.6 mi), 3) West Fork Battle Creek (4.9 mi), 4) Bear Creek (0.7 mi), and 5) Rambler Creek (0.5 mi). Documentation of heavy metal contamination in other streams on the Forest is sparse and not believed to be a

significant problem. The five streams with elevated heavy metals are believed to be outside of the range of natural variability for water quality.

Timber management, road construction, livestock grazing, water development, hard-rock mining and recreation impacts have affected water quality and the integrity of the fluvial systems. These effects are more localized and less apparent than historic tie-drive effects and dredge mining. There are no known documented cases of stream channel alterations on the Forest, as a result of forest canopy induced changes in water yield. In a study of Medicine Bow National Forest streams, with up to 23 percent of the watershed clearcut, Marston and Wick (1993) found channel morphology to be within the range of natural variation. Subtle changes may have occurred, but are likely not significant, especially since the water yield changes are believed to be within the range of historic variability.

An assessment of water quality from the WCF is displayed in Figure 2 and in detail in Appendix A. The Water Quality indicator as defined in the framework "addresses the expressed alteration of physical, chemical, and biological components of water quality". This assessment showed that water quality in most watersheds within the project area, with the exception of Haggarty Creek, North Fork Little Snake River and Encampment River-Billie Creek, is classified as functioning properly with regards to water quality. The Haggarty Creek and the Roaring Fork Little Snake River impairment information has been disclosed above. The Encampment River-Billie Creek subwatershed is functioning at risk, and recovering from a ditch overtop that created gullies, and introduced sediment into Billie Creek (USDA, 2003).

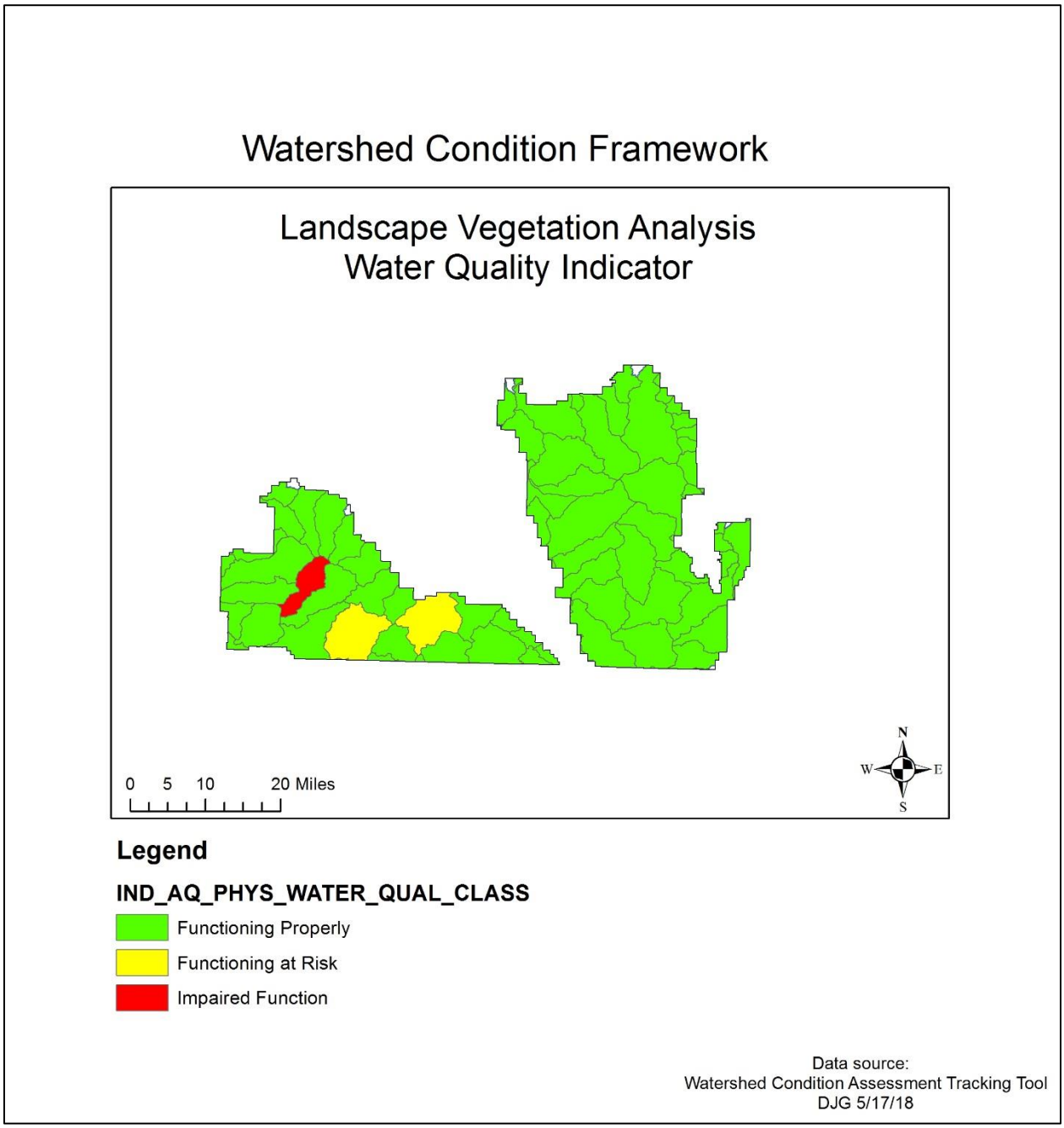

Figure 2. Distribution of Water Quality Indicator Ratings

Natural processes such as fire and also human disturbances such as road construction can affect sediment levels in streams. Roads create a pulse of sediment immediately following construction and then sediment levels decrease. Some level of erosion from roads remains as a constant source of sediment over time. Several publications (Sugden and Woods 2007; Trombulak and Frissell 2000) have shown that unpaved forest roads represent a major source of sediment. Sediment from roads can affect water quality, aquatic habitat, sediment transport regimes, and channel morphology. Roads located within 300 feet of streams, in general, have the highest potential to deliver sediment to streams (Ketcheson and Megahan 1996, Burroughs and King 1989). The existing condition related to the

transportation system was established using the WCF and its "Roads and Trails" indicator, which "addresses changes to the hydrologic and sediment regimes because of the density, location, distribution, and maintenance of the road and trail network" (USDA, 2011b). Within the LaVA project area, 16 subwatersheds have an "Impaired" rating; 46 subwatersheds have a functioning at risk rating; 4 subwatersheds have a "functioning properly" rating. Appendix A lists the rating for each watershed, and Figure 3 below displays the distribution of the Roads and Trails indicator ratings across LaVA. Looking at the rating of specific attributes from the Roads and Trails indicator, 28 watersheds had an "Impaired" condition for "Road Density"; 31 watersheds had an "Impaired" condition for "Proximity to Water".

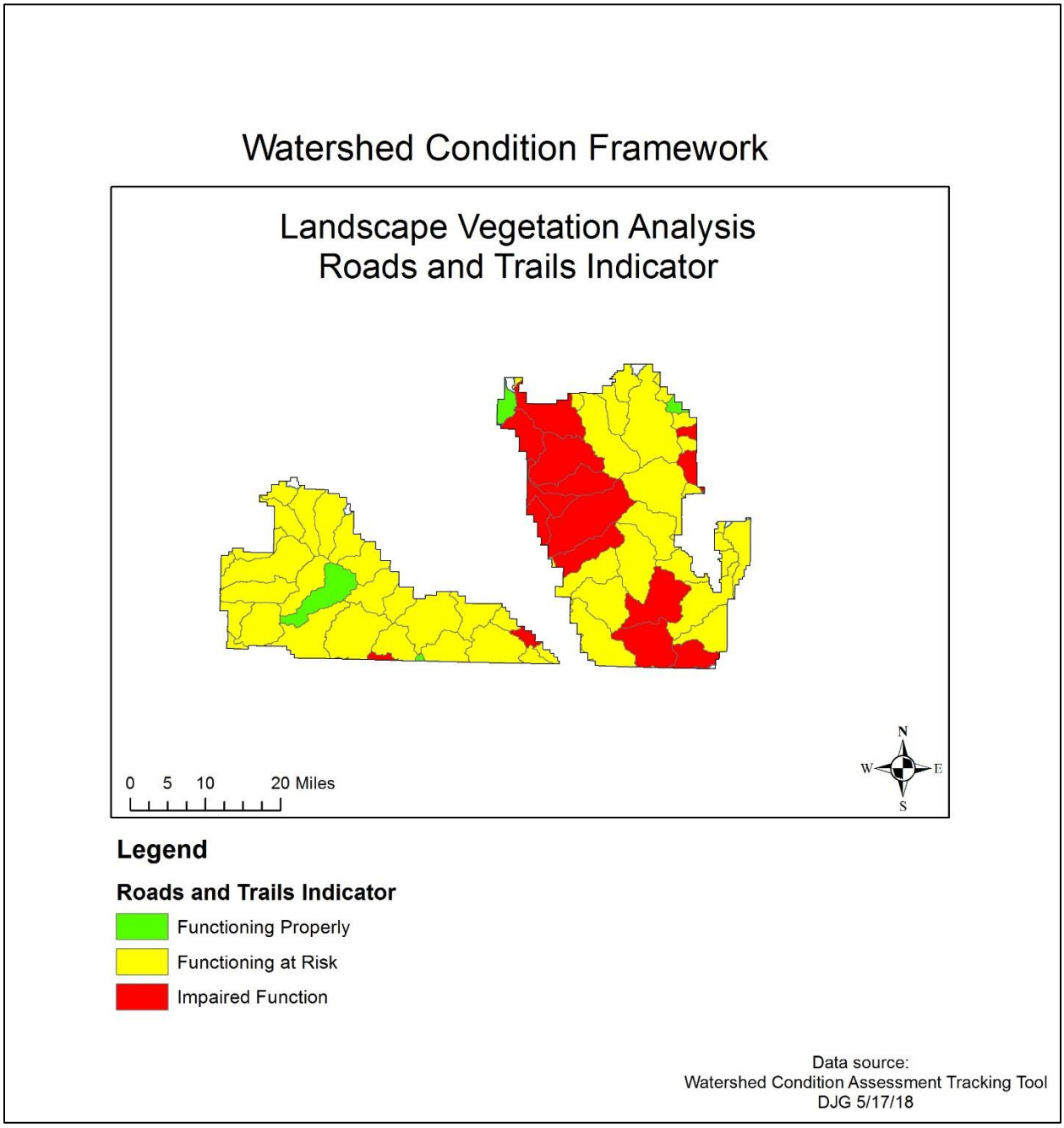

Figure 3. Distribution of Roads and Trails Indicator Ratings.

Riparian vegetation act variously as sink and filter for sediment, pesticides, certain pathogens and nutrient constituents such as nitrogen and phosphorus. Therefore the probability of sediment delivery to streams increases sharply when mechanical disturbance occurs within the water influence zone. The existing condition related to riparian vegetation was established using the WCF and its "Riparian/Wetland Vegetation" indicator, which "addresses the function and condition of riparian vegetation along streams, water bodies, and wetlands." (USDA, 2011b). Within the LaVA project area, 57 subwatersheds have a functioning properly rating for this indicator, and the remaining nine subwatersheds have a functioning at risk rating. No watershed is impaired under the Riparian/Wetland Vegetation indicator. Appendix A lists the rating for each watershed, and Figure 4 below displays the distribution of the Riparian/Wetland Vegetation indicator ratings across LaVA.

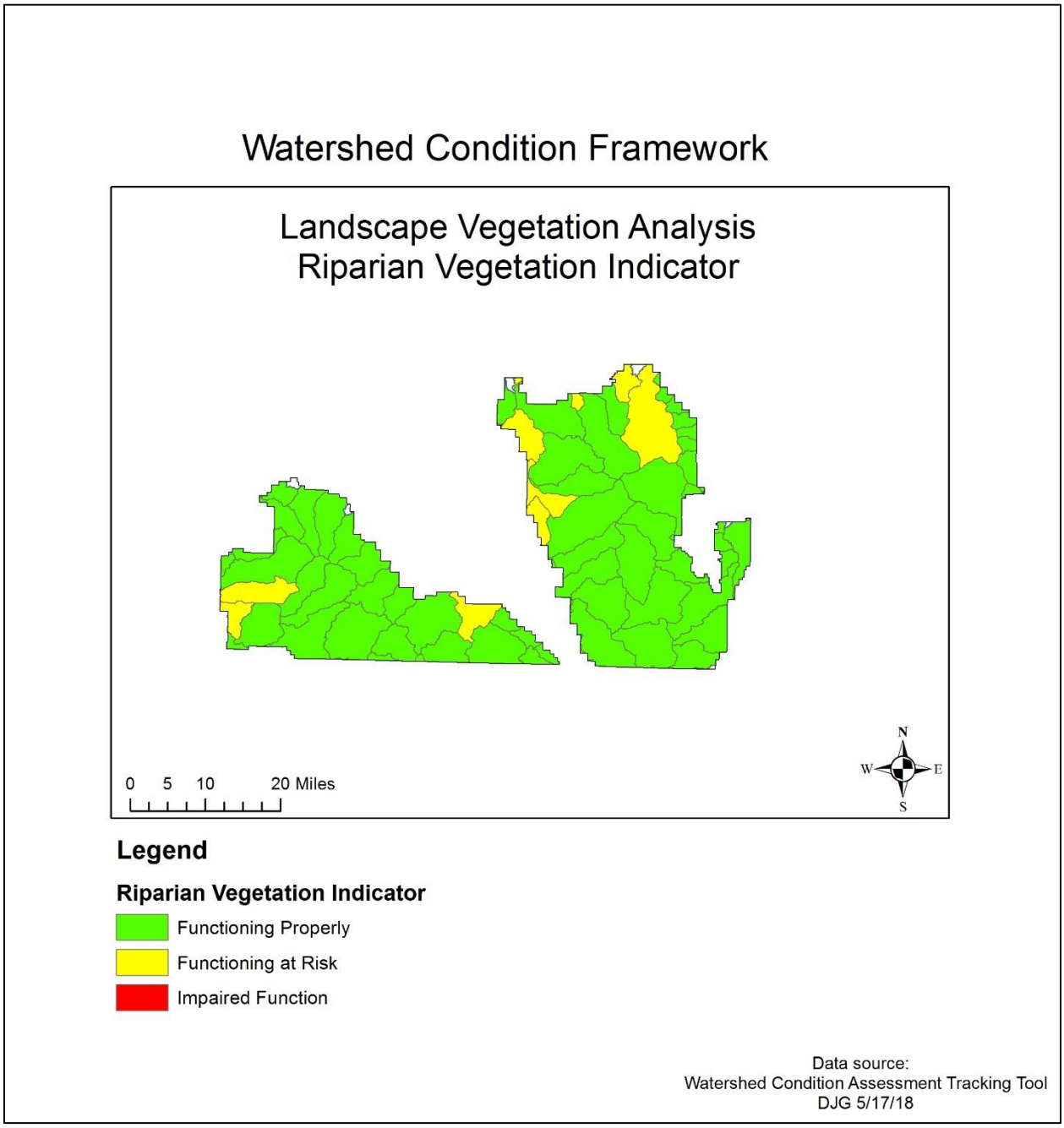

Figure 4. Distribution of Riparian/Wetland Vegetation Ratings

Water Quantity

Surface water from the project area is used on and off the Forest, both for consumptive and non-consumptive uses. Major consumptive water users include local water conservation districts and municipalities who use storage water for customers and domestic purposes, respectively. Turpin

Reservoir and Sand Lake, along with many smaller reservoirs provide storage facilities for irrigation water. The towns of Encampment and Laramie utilize water directly off the Forest for its municipal water supply, with intake diversions a few miles downstream of the forest boundary. The City of Cheyenne also utilizes water from the Forest as part of its municipal water supply system. The Cheyenne Public Board of Utilities currently maintains three reservoirs within the project area: Rob Roy, Hog Park and Lake Owen. Most other water leaving the project area also has the potential to be used for municipal water use at some more distant downstream location.

The existing condition related to water quantity was established using the WCF and its "Water Quantity" indicator, which "addresses changes to the natural flow regime with respect to the magnitude, duration, or timing of the natural streamflow hydrograph" (USDA, 2011b). Within the LaVA project area, 14 subwatersheds have an impaired rating for this indicator, 28 watersheds have a functioning at risk rating, and the remaining 24 are functioning properly. Appendix A lists the rating for each watershed, and Figure 5 below displays the distribution of the Water Quantity indicator ratings across LaVA.

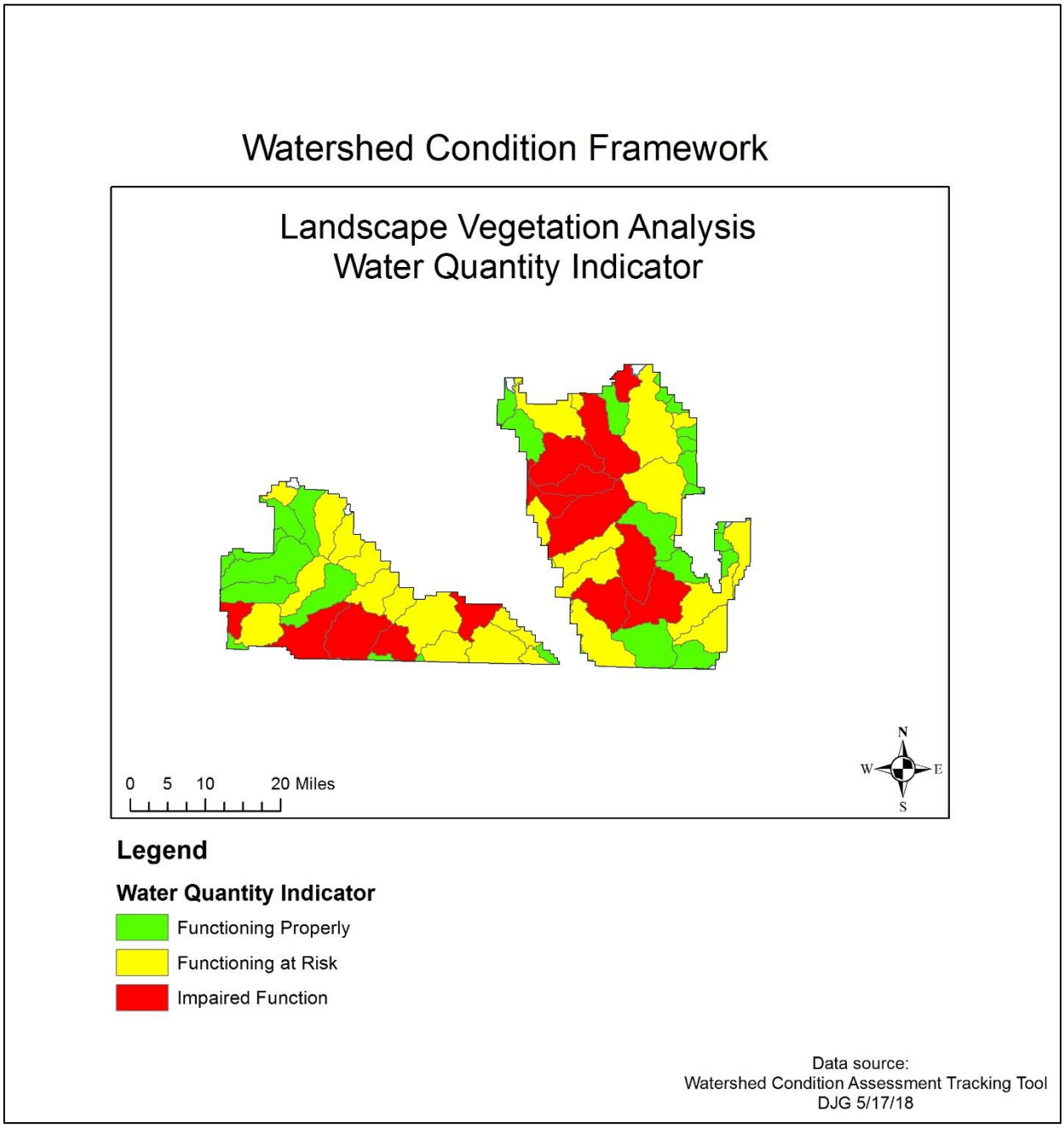

Figure 5. Distribution of Water Quantity Ratings of 6th Level Watersheds.

Equivalent Clearcut Area - Existing Conditions

The Equivalent Clearcut Area (ECA) procedure was designed to estimate streamflow responses to forest management in third to fifth order streams (King, 1989) corresponding to subwatersheds (HUC 6) of 10,000 to 40,000 acres (Ager and Clifton, 2005). ECA is used to assess the cumulative effects of vegetation treatments and roads by providing a broad indicator of changes in peak streamflows (Ager and Clifton, 2005). Depending on the interaction between water yield, sediment yield, and stream

channel conditions, such increases could have impacts on stream channels. ECA was calculated in the project area for subwatersheds (HUC 6).

Streamflow regimes can be indirectly affected by reductions of 15-25 percent of the vegetation (canopy cover) in a watershed and the resultant reduction in evapotranspiration and interception losses causing a measurable increase in runoff (e.g. Troendle et al 2001; MacDonald and Stednick 2003). Runoff and peak flows can also be indirectly affected by reductions in organic ground cover and compaction of soils from activities such as skid trails, landings, and road construction (Wemple, 1994). LaVA design criteria caps ECA levels at 25 percent within the sixth-level HUC. Therefore, watersheds having more than approximately 25 percent of their area in an "equivalent clearcut" condition are generally considered to have a high potential for changes in runoff quantities and timing. The lower the ECA percentage the higher or better the watershed condition.

Existing ECA values for the watersheds involved in the proposed project are summarized in Appendix B (Overland, 2018). ECA modeling does not directly address the additional effects of the recent beetle epidemic or reasonably forseeable future activities such as weather modification, which increased the uncertainty associated this effects analysis. The existing equivalent clearcut or disturbance levels in project area watersheds are low, as no watersheds are currently above the 25 percent ECA threshold. Based on these results, it is concluded that factors affecting water yield have not impacted the project area subwatersheds.

ENVIRONMENTAL CONSEQUENCES

Project Design Features

Effective implementation of best management practices (BMPs) outlined in the Watershed Conservation Practices (WCP) Handbook (FSH 2509.25) (USDA, 2006) is necessary to ensure compliance with State of Wyoming Water Quality Standards, the Wyoming Nonpoint Source Management Plan (WYDEQ, 2000) and the Clean Water Act. The Watershed Conservation Practices (WCP) Handbook (FSH 2509.25) provides Management Measures as well as Design Criteria and meets the intent of the Wyoming Nonpoint Source Management Plan Silvicultural Best Management Practices (WYDEQ, 2004; USDA Forest Service, 2016b). Best Management Practices most relevant to the possible suite of activities in the LaVA project are provided in Appendix C.

In addition to the Best Management Practices outlined in the WCP, there are a variety of other practices that if effectively implemented, would reduce the effects to water resources, including:

- Draft "Project Design Features" (see March 9, 2018 Issues and Alternatives memo and March 29, 2018 Revised Issues and Alternatives memo) have also been developed to reduce or prevent potential undesirable effects resulting from management activities and to ensure consistent analysis of project effects.
- Proposed treatments are planned for implementation over a 15 -20 year timeframe.

- Use of Pre-Implementation Checklist, a Project Implementation Checklist/Guide, and use of the Decision-Making Triggers.
- Specialist input and recommendations during layout and implementation
- Consideration of Connected Disturbed Area when locating roads, landings and skid trails.
- Consideration of a "Wetness Model" when locating harvest units, roads, landings and skid trails.

The Forest Service has a National BMP Program designed to provide a standard set of core BMPs and a consistent means to track and document the use and effectiveness of those BMPs on National Forest System (NFS) lands (USDA Forest Service, 2012). The Medicine Bow-Routt National Forests and Thunder Basin National Grassland have participated in the National BMP Program since 2013 and conducted 35 BMP implementation and/or effectiveness monitoring evaluations for a variety of resource categories. The monitoring protocols most relevant to the type of activities envisioned in the LaVA project are:

- "Ground-Based Skidding and Harvesting" (Veg_A): Stand initiation and intermediate Harvest Treatments; Temporary road construction for vegetation management.
- "Mechanical Site Treatments" (Veg C): Mechanical site treatments include traditional site preparation, timber stand improvements, pile burning, removal of invasive/exotic plants, and other vegetative treatments.
- "Use of Prescribed Fire" (Fire_A): Planning and implementation of prescribed fire.

Since 2013, the Forest has conducted five "Ground-Based Skidding and Harvesting" evaluations, two "Mechanical Site Treatments" evaluations and one "Use of Prescribed Fire" evaluation. Monitoring information for the eleven National Forests in Region 2 has been summarized for 2015-16 and includes seventeen "Ground-Based Skidding and Harvesting" evaluations, eighteen "Mechanical Site Treatments" evaluations and seven "Use of Prescribed Fire" evaluations (USDA Forest Service 2018). The BMP evaluations for the Forest represent local conditions, but are limited in number and have not been summarized, therefore the 2015-16 Region 2 BMP summary information will be used to estimate implementation and effectiveness of BMPs for the LaVA project. The Forest BMP data is included in the Regional assessment, which is assumed to be representative of conditions on the Forest. BMP implementation and effectiveness information is discussed below for each of the monitoring protocols and used to inform the water resources effects analysis.

"Ground-Based Skidding and Harvesting" (Veg_A): BMP implementation was rated as "Fully Implemented" or "Mostly Implemented" 69 percent of the time and "Marginally Implemented" 31 percent of the time. When implemented, BMP effectiveness ratings were "Effective" or "Mostly Effective" 78 percent of the time and "Marginally Effective" or "Not Effective" 21 percent of the time.

"Mechanical Site Treatments" (Veg C): BMP implementation was rated as "Fully Implemented" or "Mostly Implemented" 73 percent of the time and "Marginally Implemented" or "Not Implemented" 27 percent of the time. When implemented, BMP effectiveness ratings were "Effective" or "Mostly Effective" 75 percent of the time and "Marginally Effective" or "Not Effective" 25 percent of the time.

"Use of Prescribed Fire" (Fire_A): BMP implementation was rated as "Fully Implemented" or "Mostly Implemented" 57 percent of the time and "Marginally Implemented" or "Not Implemented" 42 percent

of the time. When implemented, BMP effectiveness ratings were “Effective” 86 percent of the time and “Not Effective” 14 percent of the time.

The State of Wyoming BMP monitoring program found projects on National Forest System lands within Wyoming have a BMP application rate of 96 percent, and were 97 percent effective in providing adequate protection (WSFD, 2014).

Following the Region 2 Nonpoint Source Management Strategy (FSH 2509.25 Chapter 20), including applying BMPs, monitoring the implementation and effectiveness of BMPs, and making adjustments as needed is critical to meet State water quality standards.

Monitoring

As part of the LaVA Adaptive Implementation and Monitoring Framework (details found in Appendix X of the EIS), decision-making triggers have been established to indicate if a resource has the potential to be negatively impacted by treatment proposals, demonstrating the need for more rigorous Project Design Features, change in management approach, or slowing the pace of implementation. Triggers were established for watershed resources, and includes reviewing disturbance acreages prior to treatment design and layout to determine percent ECA. Adaptive action are then established based on subwatershed’s proximity to the 25 percent ECA cap.

Additionally, implementation and effectiveness of both Best Management Practices and project design features will be monitored annually, and future treatments will be modified to avoid any resource concerns. Lastly miles of temporary roads will be tracked to determine if road construction and percent rehabilitation has occurred in the allotted timeframe. Adaptive actions will be implemented to meet temporary road construction targets, and to ensure that temporary roads are effectively rehabilitated within 3 years of treatment completion.

Alternative 1 - No Action

Direct Effects – No Action

Watershed Condition

Under the no-action alternative, no mechanized vegetation treatments, prescribed burning, or temporary road construction would take place. Watershed condition ratings would remain unchanged and there would be no direct effects from proposed activities under this alternative. The no action alternative would continue to suppress most fires in the project area. An indirect effect would be the no reduction of fuels across the project area, which in turn increases the risk of adverse effects to watershed condition from wildland fire. The Beaver Creek (38,379 acres), Broadway (2,121 acres), and Snake (2,565 acres) fires of 2016 provide an indication of potential fire effects with current fuel conditions.

Water Quality

There would be no increases in sediment as a result of ground disturbance associated with timber harvest and the associated transportation system. There will be no ground disturbance or removal of vegetation along the water influence zone. Indirect effects under the no action alternative include the potential for increased sediment delivery to streams from an increase in the wildfire hazard due to not implementing an action alternative. If a fire were to occur, direct effects may result from fire suppression activities, such as the construction of firelines especially in or near stream channels, and indirect effects could occur as a result of changes in vegetative cover, formation of water repellent soils, and increases in runoff. The extent of these effects could range from minor to severe and are only speculative at this time due to the spatial and temporal variability of wildfires. Direct effects on streamflow would not occur. Indirect effects from natural processes such as forest fire and insect and disease may reduce canopy cover and are expected to continue under the no action alternative.

Cumulative Effects –

There are no activities proposed for alternative 1, therefore, no cumulative effects.

Alternative 2 – Modified Proposed Action

The proposed action is to conduct vegetation management activities on the Medicine Bow National Forest, including in Inventory Roadless Areas (IRAs). The proposed treatments are to protect, restore and enhance forest ecosystem components; reduce wildfire risk to communities and municipal water supplies; supply forest products to local industries; and improve, protect, and restore wildlife habitat. Vegetation management activities include prescribe fire, mechanical, and hand treatments on 150,000 – 360,000 acres over the next 15-20 years. No more than 600 miles of temporary road would be constructed and no new permanent or temporary roads would be constructed in IRAs.

The final treatment acres and roads will be dependent on maintaining watershed condition as indicated by a 25 percent ECA threshold at the sixth-level watershed. Maximum disturbance, including natural disturbances and treatments, based on the ECA cap would total 146,424 equivalent clearcut acres for all watersheds in the project area (see Appendix B for calculation of maximum disturbance per watershed).

The LaVA project has been designed to minimize water resources effects through the LaVA Adaptive Implementation and Monitoring Framework which includes monitoring of BMP, design features, and temporary roads to ensure that actual treatments meet desired condition. It will ultimately be through this framework that actual treatments would be established, and to ensure compliance with the Forest Plan.

Direct Effects – Proposed Action

Watershed Condition

The magnitude of watershed condition impacts is highly uncertain given the absence of spatial and temporal details of proposed treatments. However, the LaVA project has been designed to minimize watershed effects through the LaVA Adaptive Implementation and Monitoring Framework. This framework would establish actual treatments, ensuring compliance with the Forest Plan, and fully maintaining or improving designated beneficial uses. While ratings for individual watershed condition

indicators such as roads/trails or riparian vegetation may be affected by LaVA treatments, the overall watershed condition class is expected to be maintained or improved. It is recommended that the existing watershed condition indicator ratings as summarized above in this report be used to support the ECA model validation process proposed in the LaVA monitoring framework. The WCF indicators provide a higher level of detail, at the same ECA spatial scale (subwatershed scale – HUC 6).

Water Quality - Stand Initiation and Intermediate Harvest Treatments

Table 3 and Figure 6 show existing and projected quantities of harvest in wetlands (Gloss, 2018). Harvest treatments in the wetland can be used as a quantitative indicator to estimate the potential direct effects of the proposed project.

Table 3. HARVEST: WETLAND Indicator/Metric (*Direct Effect*)

Background	
Wetlands in Project Area	27,594 acres
Existing Conditions	
Harvest (1934 – 2017)	139,129 acres
Harvest in Wetlands (1934 – 2017)	1,112 acres (0.80%)
Current Forest Plan Period (used to project forward for LaVA)	
Harvest (2004 – 2017)	7,685 acres
Harvest in Wetland (2004 – 2017)	45.3 acres (0.59%)
Lava Proposed Action – Projections (proposed stand initiation and intermediate harvest)	
Lava Proposed Action Harvest (~2019-2039)	260,000 acres[1]
Lava Proposed Action Projected Harvest in Wetlands	1,534 acres (0.59%)

[1] 95,000 stand initiation harvest + 165,000 intermediate harvest

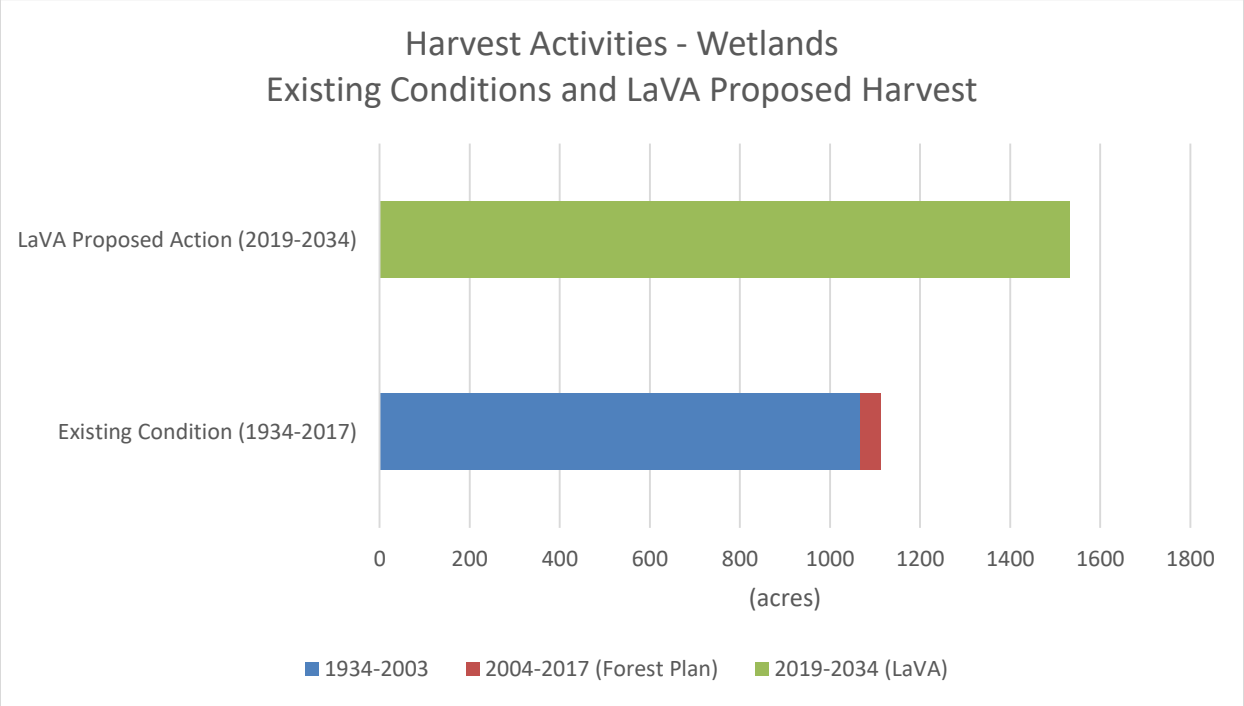

Figure 6: HARVEST: WETLAND Indicator/Metric (*Direct Effect*)

Of the 7,685 acres of timber harvest in the last 14 years, under the existing Forest Plan, approximately 45 acres (0.59%), has occurred in wetlands. In the next 15-20 years under the LaVA project, an estimated 1,534 acres of harvest is likely to occur in wetlands assuming all 260,000 acres of stand initiation and intermediate treatments occur. The amount of harvest in wetlands under the LaVA project is expected to be 1.4 times the amount of harvest in wetlands that has occurred on the Forest since the 1930s or about 34 times the amount of harvest that has occurred in wetlands in the 14 years implementing the current Forest Plan.

Water Quality - Transportation

Two indicators were selected as quantitative indicators of potential direct effects of the proposed temporary road construction on water quality: 1) Number of road-stream crossings and 2) miles of road construction through wetlands.

Road-stream crossings and temporary roads within wetlands deliver a continuous input of sediment into adjacent streams and wetlands, the amount of which differ depending on road surfacing, volume of traffic, soil type and other factors. The road reconstruction and maintenance work, culvert cleaning and replacement along with increased traffic due to hauling from the proposed treatments, could potentially result in short-term increases in sediment delivery beyond normal levels. Table 4 and Figure 7 show existing and projected quantities of road-stream crossings (Gloss, 2018). Road-stream crossings can be used as a quantitative indicator to estimate the potential direct effects of the proposed project.

Table 4. **ROADS: STREAM CROSSINGS Indicator/Metric (*Direct Effect*) Table**

Existing Conditions	
NFS Roads (FS jurisdiction)	2,113 miles

NFS Roads – Stream Crossings	Perennial Streams: 590 Intermittent Streams: 843 Ephemeral Streams: 1401
Current Forest Plan Period (used to project forward for LaVA)	
Temporary Road Construction (2004 – 2017)	30.2 miles
Temporary Road Construction Stream Crossings (2004 – 2017)	Perennial Streams: 1 Intermittent Streams: 3 Ephemeral Streams: 23
Lava Proposed Action – Projections (temporary road construction)	
Lava Proposed Action – Road Construction (~2019-2039)	600 miles[1]
Lava Proposed Action Projected Road Construction[1] Stream Crossings	Perennial Streams: 20 Intermittent Streams: 60 Ephemeral Streams: 457

[1] Temporary roads

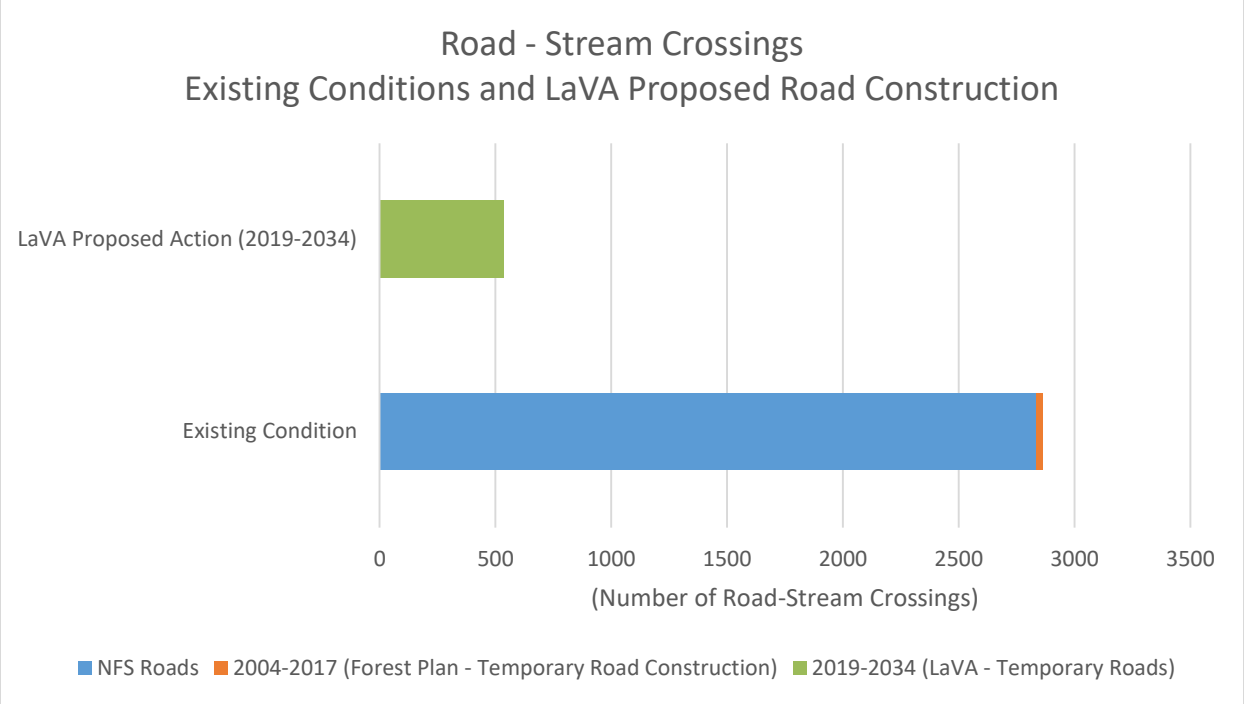

Figure 7. **ROADS: STREAM CROSSINGS Indicator/Metric (*Direct Effect*)**

Construction of the 30 miles of temporary road in the last 14 years, under the existing Forest Plan, resulted in 27 road-stream crossings. In the next 15-20 years under the LaVA project, an estimated 537 road-stream crossings are likely to be constructed assuming all 260,000 acres of stand initiation and intermediate treatments occur. The amount of road-stream crossings constructed under the LaVA project is expected to be 1/5th the amount of system road-stream crossings that exist on the Forest or

about 20 times the amount of road-stream crossings that has occurred in the 14 years implementing the current Forest Plan.

Table 5 and Figure 8 show existing and projected quantities of road construction in wetlands (Gloss, 2018). Road construction in wetlands can be used as a quantitative indicator to estimate the potential direct effects of the proposed project.

Table 5. **ROADS: WETLAND Indicator/Metric (*Direct Effect*) Table**

Background	
Wetlands in Project Area	27,594 acres
Existing Conditions	
NFS Roads (FS jurisdiction)	2,113 miles
NFS Roads in Wetlands	15.3 miles (0.72%)
Current Forest Plan Period (used to project forward for LaVA)	
Temporary Road Construction (2004 – 2017)	30.2 miles
Temporary Road Construction in Wetland (2004 – 2017)	0.04 miles (0.13%)
Lava Proposed Action – Projections (temporary road construction)	
Lava Proposed Action – Road Construction (~2019-2039)	600 miles[1]
Lava Proposed Action Projected Road Construction[1] in Wetland	0.8 miles (0.13%)

[1] Temporary roads

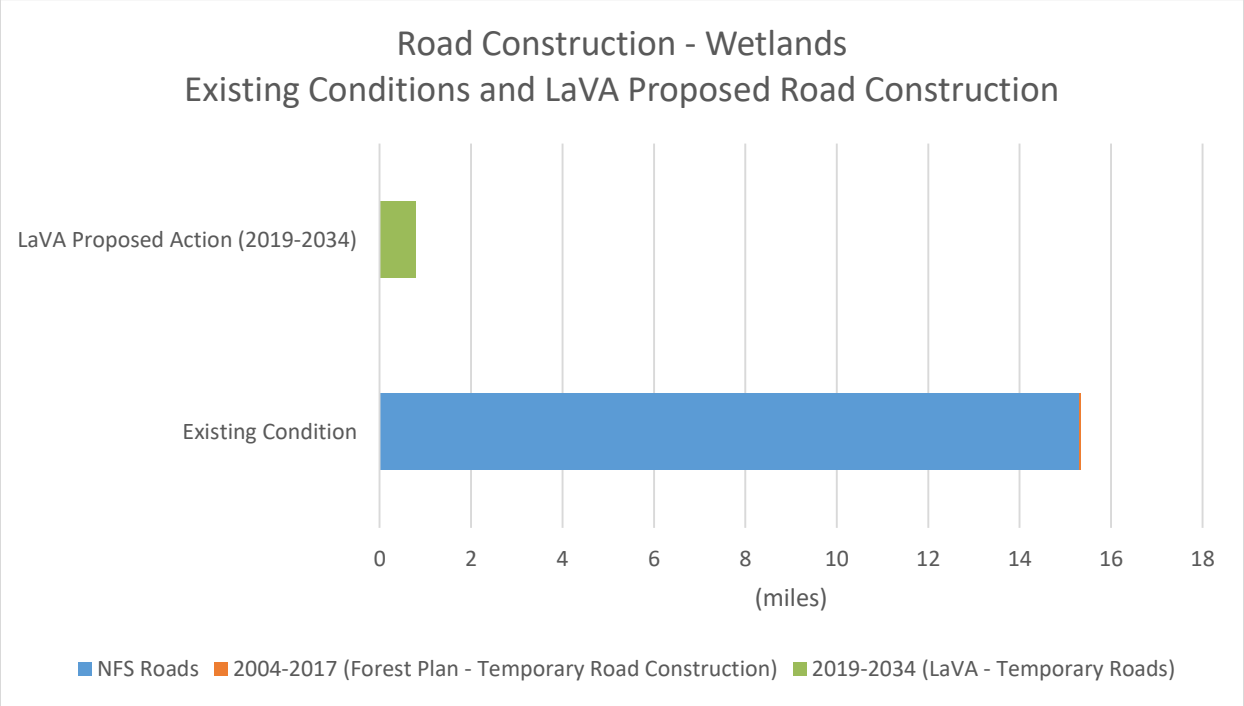

Figure 8. **ROADS: WETLAND Indicator/Metric (*Direct Effect*)**

Of the 30 miles of temporary road constructed in the last 14 years, under the existing Forest Plan, approximately 0.04 miles (0.13%), has been constructed through wetlands. In the next 15-20 years under the LaVA project assuming all 260,000 acres of stand initiation and intermediate treatments occur, an estimated 0.8 mile of temporary road construction is likely to be constructed through wetlands. The amount of temporary road construction in wetlands under the LaVA project is expected to be 1/20th the amount of system road in wetlands that exists on the Forest or about 20 times the amount of temporary road construction that has occurred through wetlands in the 14 years implementing the current Forest Plan.

It is recognized that due to the increased road activity short term direct and indirect effects would be expected from temporary roads within wetlands and at stream crossings. These may include increased turbidity and suspended sediment values. Sedimentation may impact the immediate footprint of the road/stream crossing location and a short distance of channel downstream of the site, with effects diminishing further downstream. Most project-related sediment would likely mobilize during the initial high flow event the following rainy season. The magnitude and extent of the effects would be lessened by the implementation of BMPs and design features, including limiting activity during wet weather. The LaVA Adaptive Implementation and Monitoring Framework lists the use of a Wetness Index Modelling (WIM) to aid in placing temporary roads outside wet areas. This will help maintain wetland habitats and greatly reduce sedimentation into stream channels. It will ultimately be up to this framework to establish actual treatments, and to ensure compliance with the Forest Plan.

Water Quality and Fuels Treatments

Fuels treatments, including burning and mechanical and hand fuels treatments, have the potential of causing increased sedimentation and ash and soot deposition into streams if BMPs and design criteria are not properly implemented. These effects would come primarily from prescribed burning, mechanical treatments and firelines nearby streams. Design criteria includes a 100 foot buffers typically applied to the harvest units along perennial and intermittent streams, riparian areas and wetlands during project layout. Possible effects to water quality, riparian and wetland areas depend upon the extent and intensity of the treatments particularly those involving ground disturbances. Some of the riparians and wetlands may be lightly burned, but the effect should not be significant. No discernible direct and indirect effects to water quality would be expected as long as a criteria of no ignition within buffers, low fire severity, and low soil burn severity are maintained and live vegetation left to act as a sediment filter strip. Although a short-term degradation could occur, reintroduction of fire into this landscape and movement toward a more natural fire regime would have a long-term benefit.

Indirect Effects – Proposed Action

Water Quality - Stand Initiation and Intermediate Harvest Treatments

Table 6 and Figure 9 show existing and projected quantities of harvest in the Water Influence Zone (Gloss, 2018). Harvest treatments in the Water Influence Zone can be used as a quantitative indicator to estimate the potential indirect effects of the proposed project.

Table 6. **HARVEST: WATER INFLUENCE ZONE Indicator/Metric (streams, lakes/ponds, wetlands)**

Background	
Water Influence Zone in Project Area (streams, lakes/ponds, wetlands)	123,023 acres
Existing Conditions	
Harvest (1934 – 2017)	139,129 acres
Harvest in WIZ (1934 – 2017)	8,695 acres (6.25%)
Current Forest Plan Period (used to project forward for LaVA)	
Harvest (2004 – 2017)	7,685 acres
Harvest in WIZ (2004 – 2017)	499 acres (6.49%)
Lava Proposed Action – Projections (proposed stand initiation and intermediate harvest)	
Lava Proposed Action Harvest (~2019-2039)	260,000 acres[1]
Lava Proposed Action Projected Harvest in WIZ	16,874 acres (6.49%)

[1] 95,000 stand initiation harvest + 165,000 intermediate harvest

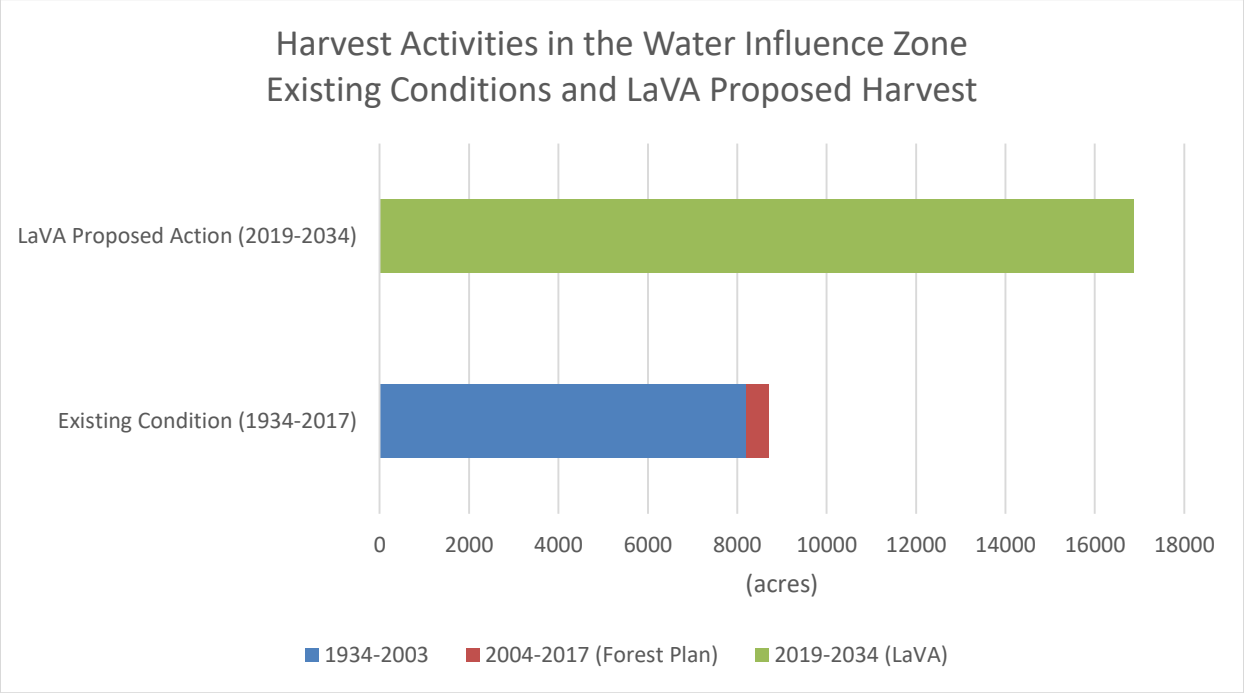

Figure 9. **HARVEST: WATER INFLUENCE ZONE Indicator/Metric (streams, lakes/ponds, wetlands)**

Of the 7,685 acres of timber harvest in the last 14 years, under the existing Forest Plan, approximately 499 (6.49%), has occurred in the Water Influence Zone next to streams, lakes and wetlands. In the next 15-20 years under the LaVA project assuming all 260,000 acres of stand initiation and intermediate treatments occur, an estimated 16,874 acres of harvest is likely to occur in the Water Influence Zone. The amount of harvest in the Water Influence Zone under the LaVA project is expected to be twice the amount of harvest in the Water Influence Zone that has occurred on the Forest since the 1930s or about 34 times the amount of harvest that has occurred in the Water Influence Zone in the 14 years implementing the current Forest Plan.

Water Quality - Transportation

Table 7 and Figure 10 show existing and projected quantities of road construction in the Water Influence Zone (Gloss, 2018). Road construction in the Water Influence Zone can be used as a quantitative indicator to estimate the potential indirect effects of the proposed project.

Table 7. **ROADS: WATER INFLUENCE ZONE Indicator/Metric (streams, lakes/ponds, wetlands)**

Background	
Water Influence Zone in Project Area (streams, lakes/ponds, wetlands)	123,023 acres
Existing Conditions	
NFS Roads (FS jurisdiction)	2,113 miles
NFS Roads in WIZ	224 miles (10.6%)

Current Forest Plan Period (used to project forward for LaVA)	
Temporary Road Construction (2004 – 2017)	30.2 miles
Temporary Road Construction in WIZ (2004 – 2017)	0.6 miles (1.99%)
Lava Proposed Action – Projections (temporary road construction)	
Lava Proposed Action – Road Construction (~2019-2039)	600 miles[1]
Lava Proposed Action Projected Road Construction[1] in WIZ	12 miles (1.99%)

[1] Temporary roads

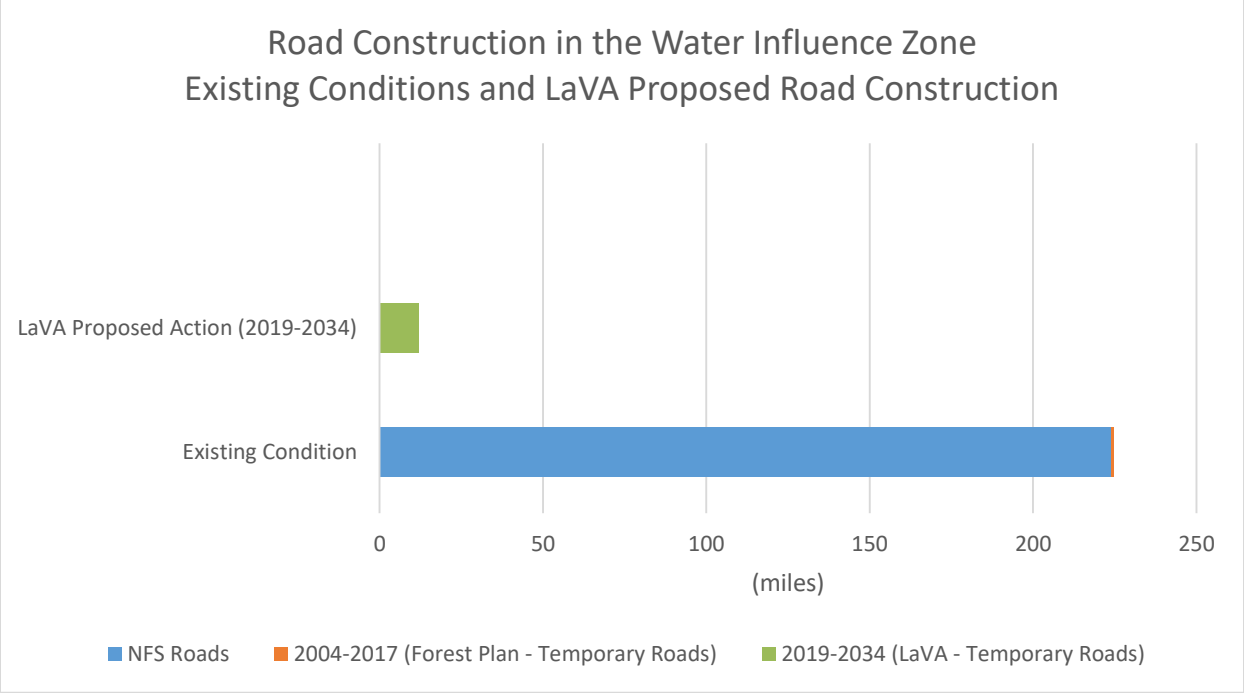

Figure 10. **ROADS: WATER INFLUENCE ZONE Indicator/Metric (streams, lakes/ponds, wetlands)**

Of the 30 miles of temporary road constructed in the last 14 years, under the existing Forest Plan, approximately 0.6 miles (1.99%), has been constructed in the Water Influence Zone next to streams, lakes and wetlands. In the next 15-20 years under the LaVA project assuming all 260,000 acres of stand initiation and intermediate treatments occur, an estimated 12 miles of temporary road construction is likely to be constructed in the Water Influence Zone. The amount of temporary road construction in the Water Influence Zone under the LaVA project is expected to be 1/20th the amount of system road in the Water Influence Zone that exists on the Forest or about 20 times the amount of temporary road construction that has been constructed in the Water Influence Zone in the 14 years implementing the current Forest Plan.

Cumulative Effects – Proposed Action

Cumulative effects associated with proposed treatments include a decrease in tree canopy and an associated increase in water available for stream flow and potential modifications to peak flow timing. The potential increase in water available for stream flow is due to decreases in interception and transpiration. In wet climates, this can increase annual water yield. The amount of change in canopy cover necessary to produce a significant effect on water yield is approximately 25 percent. Appendix B shows the maximum allowable disturbance for each sixth-level watershed shown as Equivalent Clearcut Area. No sixth-level watershed would have more than 25 percent of its area (ECA) disturbed.

Table 8. Summary of the Effects from the Modified Proposed Action assuming all 260,000 acres of stand initiation and intermediate treatments occur

Resource Element	Resource Indicator	Measure	Forest Plan period (2004-17)	LaVA Modified Proposed Action (2019-2039)
Road Construction				
Water Quality	Sedimentation – Direct Effect	Road-stream crossings (#)	27	534
Water Quality & Wetland	Sedimentation – Direct Effect	Road construction in wetland (miles)	0.04	0.8
Water Quality	Sedimentation – Indirect Effect	Road construction in water influence zone (miles)	0.6	12
Stand initiation and intermediate harvest treatments				
Water Quality & Wetland	Sedimentation – Direct Effect	Harvest in wetland (acres)	45	1,534
Water Quality	Sedimentation – Indirect Effect	Harvest in water influence zone (acres)	499	16,874
Water Quantity	Water yield	Equivalent Clearcut Area (Percent basal area removed)		Maximum of 25 percent or 146,424 acres

COMPLIANCE WITH REGULATORY DIRECTION

Water resources effects analyses presented in the Forest Plan were based in part on projected levels of harvest. Comparison of Forest Plan and LaVA activity levels can be used as one indicator of how potential water resource effects relate to regulatory direction. The draft environmental impact statement for the Forest Plan analyzed a “Maximum Timber Yield Alternative”. This alternative, “[t]he maximum timber benchmark has an ASQ of 64.7 MMBF/year in the first decade, with harvest occurring on 7,438 acres/year.” The LaVA project has been designed to be consistent with the allowable sale quantity (ASQ) as established in the Forest Plan (Westfahl, 2018). The LaVA project implementation

would minimize water resources effects through the LaVA Adaptive Implementation and Monitoring Framework. This framework would establish actual treatments, ensuring compliance with the Forest Plan, and water and aquatic standards and guidelines including maintenance or improvement of long-term hydrologic and riparian function, channel stability, and riparian and stream habitat.

In addition to the Best Management Practices outlined in the WCP, there are a variety of other innovative practices that are planned for implementation to both reduce the effects of the LaVA project implementation on water resources and also be used to determine compliance with laws, regulations and policies during implementation, including:

- Draft "Project Design Features" (see March 9, 2018 Issues and Alternatives memo and March 29, 2018 Revised Issues and Alternatives memo) have also been developed to reduce or prevent potential undesirable effects resulting from management activities and to ensure consistent analysis of project effects.
- Proposed treatments are planned for implementation over a 15-20 year timeframe.
- Use of Pre-Implementation Checklist, a Project Implementation Checklist/Guide, and use of the Decision-Making Triggers.
- Monitoring Plan
- Specialist input and recommendations during layout and implementation
- Consideration of Connected Disturbed Area when locating roads, landings and skid trails.
- Consideration of a "Wetness Model" when locating harvest units, roads, landings and skid trails.

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APPENDIX A – WATERSHED CONDITION FRAMEWORK

Watershed Condition Class I, functioning properly ranges from 1 to 1.6. Watershed Condition Class II, functioning at risk ranges from 1.7 to 2.2 Watershed Condition Class III, impaired ranges from 2.3 to 3.0.

Watershed Condition Assessment Tracking Tool was queried May 17, 2018

HUC12_CODE	HUC12_NAME	Watershed Class Score	Indicator - Riparian Vegetation Score	Indicator - Water Quality Score	Indicator - Water Quantity Score	Indicator - Roads and Trails Score
101800020101	North Platte River-Sixmile Creek	1.7	1.0	1.5	2.0	1.8
101800020102	Camp Creek	1.8	1.0	1.5	2.0	1.8
101800020104	Upper Douglas Creek	2.0	1.0	1.5	3.0	2.0
101800020105	Middle Douglas Creek	2.1	1.0	1.5	3.0	2.3
101800020106	Pelton Creek	1.8	1.0	1.5	1.0	2.3
101800020107	Lower Douglas Creek	2.0	1.0	1.5	3.0	2.0
101800020201	Cottonwood Creek-North Platte River	1.9	1.0	1.5	2.0	2.0
101800020202	Mullen Creek	2.0	1.0	1.5	2.0	2.3
101800020203	French Creek	2.1	1.0	1.5	3.0	2.5
101800020204	North Cottonwood Creek-North Platte River	2.0	2.0	1.5	2.0	2.3
101800020205	Beaver Creek	2.0	2.0	1.5	3.0	1.8
101800020301	South Fork Big Creek	1.9	1.0	1.5	2.0	2.0
101800020302	North Fork Big Creek	1.9	1.0	1.5	2.0	2.0
101800020303	Henry Creek-Big Creek	1.9	1.0	1.5	2.0	2.3
101800020304	Spring Creek-Big Creek	1.7	1.0	1.5	1.0	2.0
101800020305	Bear Creek	1.7	1.0	1.5	2.0	1.8
101800020401	South Brush Creek	2.0	1.0	1.5	3.0	2.5
101800020402	North Brush Creek	2.0	1.0	1.5	3.0	2.5
101800020403	Barrett Creek-Brush Creek	2.2	2.0	1.5	3.0	2.3
101800020502	Encampment River-West Fork	1.6	1.0	1.5	1.0	1.3
101800020503	East Fork Encampment River	1.9	1.0	1.5	2.0	1.8
101800020504	Billie Creek-Encampment River	1.9	1.0	2.0	2.0	1.8
101800020505	Hog Park Creek	2.0	1.0	1.5	3.0	2.0
101800020506	Miner Creek	1.8	1.0	1.5	2.0	2.0
101800020507	North Fork Encampment River	1.9	1.0	1.5	2.0	2.0
101800020602	Cow Creek	1.8	1.0	1.5	2.0	2.0
101800020603	Cedar Creek	2.0	2.0	1.5	1.0	2.8
101800020605	Upper Lake Creek	1.5	1.0	1.5	1.0	1.3
101800020701	Methodist Creek-North Spring Creek	1.8	1.0	1.5	2.0	2.0
101800020703	South Spring Creek	1.8	1.0	1.5	2.0	2.0
101800020801	Upper Jack Creek	1.7	1.0	1.5	1.0	2.0
101800021101	Lee Creek-Pass Creek	2.0	1.0	1.5	2.0	2.3
101800021102	Little Pass Creek-Pass Creek	1.9	2.0	1.5	2.0	2.0
101800040101	Turpin Creek-Medicine Bow River	2.0	1.0	1.5	3.0	2.0
101800040102	East Fork Medicine Bow River	1.8	1.0	1.5	1.0	2.0
101800040106	Wagonhound Creek	2.1	2.0	1.5	3.0	2.0
101800040201	Deep Creek-Rock Creek	2.0	2.0	1.5	2.0	1.8
101800040204	Threemile Creek	1.6	1.0	1.5	1.0	1.8
101800100201	Laramie River-Bear Creek	1.9	1.0	1.5	2.0	2.0
101800100203	Boswell Creek	1.8	1.0	1.5	1.0	2.3
101800100204	Fox Creek	1.9	1.0	1.5	2.0	2.0
101800100402	Lake Hattie Reservoir	1.4	1.0	1.5	2.0	1.8
101800100601	Headwaters Little Laramie River	1.8	1.0	1.5	1.0	1.8
101800100602	South Fork Little Laramie River	1.8	1.0	1.5	1.0	2.0
101800100603	North Fork Little Laramie River	1.9	1.0	1.5	2.0	2.0
101800100604	Upper Little Laramie River	1.5	1.0	1.5	1.0	2.0
101800100606	Mill Creek	1.4	1.0	1.5	1.0	2.3
101800100702	Fourmile Creek	1.8	1.0	1.5	1.0	2.3
101800100703	Sevenmile Creek	1.6	1.0	1.5	1.0	1.8
101800100801	Cooper Creek	1.8	1.0	1.5	2.0	1.8
101800100803	Upper Dutton Creek	1.5	1.0	1.5	1.0	1.3
140500030101	Little Snake River-Whiskey Creek	1.8	1.0	1.5	1.0	2.3
140500030103	Little Snake River-Tennessee Creek	1.7	1.0	1.5	2.0	2.3
140500030104	North Fork Little Snake River	1.7	1.0	2.0	3.0	1.8
140500030106	Little Snake River-Roaring Fork	1.9	1.0	1.5	3.0	2.0
140500030108	Upper Battle Creek	1.6	1.0	1.5	1.0	1.5
140500030109	West Fork Battle Creek	1.8	1.0	3.0	2.0	1.8
140500030110	Lower Battle Creek	1.7	1.0	1.5	2.0	1.8
140500030201	Little Snake River-Fly Creek	1.3	1.0	1.5	1.0	1.8
140500030401	East Fork Savery Creek	1.7	1.0	1.5	1.0	1.8
140500030402	Dirtyman Fork	1.3	1.0	1.5	1.0	1.8
140500030403	Upper Savery Creek	1.5	1.0	1.5	1.0	2.0
140500030404	North Fork Savery Creek	1.8	1.0	1.5	2.0	2.0
140500030407	Big Sandstone Creek	1.7	1.0	1.5	1.0	1.8
140500030408	Lower Savery Creek	2.0	2.0	1.5	3.0	2.0
140500030409	Little Sandstone Creek	1.8	2.0	1.5	1.0	1.8

APPENDIX B – EQUIVALENT CLEARCUT AREA

The Equivalent Clearcut Area (ECA) methodology is used to evaluate the cumulative watershed effects for the LaVa Project Area. The range of ECA values range from a value of 0 (100 percent forested landscape) to 100 (Clearcut where all vegetation is removed). All Forest Service activities (harvest, site, preparation, fire history, transportation, recreation, etc.) are evaluated using this scale based on the percentage of basal area removed in that area and receives an ECA value. Various vegetation management activities have different ECA values, e.g. a clearcut has an ECA Equivalent of 100% (or 1.0), whereas an improvement cut will have a value of 20% (or 0.20). The time scale for recovery from a Clearcut to 100 percent forested area is 80 years. For example, a clear cut harvested in 1978 (40 years old) will have a score of 100 percent times a time recovery equation since harvest, resulting in a 50 percent reduction of ECA in the year 2018. All ECA values above are adjusted for both intensity and time scales.

All overlaps are removed retaining the most recent entry. Lastly, the adjusted ECA scores are spatially lumped to the watershed boundaries at the subwatershed (HUC 6) scale. The table below shows the summary of all FS activities recorded since the year 1938 in terms of ECA, the maximum ECA disturbance acreage not to exceed 25 percent ECA, and the existing watershed condition class.

Subwatershed (HUC 6)	Acres	NFS Acreage	2017 ECA Acres*	Existing ECA Percent of NFS lands	Maximum ECA Equivalent Disturbance Acreage	Existing Watershed Condition Class	ECA Percent-No Action Alt 2039
101800020101	24,602	24,598	1,317	5%	4,833	2	3%
101800020104	24,926	23,452	3,238	14%	2,625	2	7%
101800020105	25,578	25,107	3,077	12%	3,200	2	7%
101800020106	23,445	22,459	1,856	8%	3,758	2	5%
101800020107	21,428	21,428	1,032	5%	4,325	2	2%
101800020201	16,547	16,417	435	3%	3,670	2	1%
101800020202	15,890	15,877	1,342	8%	2,627	2	4%
101800020203	37,569	37,404	4,664	12%	4,687	2	5%
101800020204	7,099	7,094	660	9%	1,114	2	4%
101800020205	12,879	12,448	876	7%	2,236	2	4%

Subwatershed (HUC 6)	Acres	NFS Acreage	2017 ECA Acres*	Existing ECA Percent of NFS lands	Maximum ECA Equivalent Disturbance Acreage	Existing Watershed Condition Class	ECA Percent-No Action Alt 2039
101800020301	3,608	3,607	138	4%	764	2	2%
101800020302	20,260	19,054	2,748	14%	2,015	2	7%
101800020303	3,531	3,483	36	1%	834	2	1%
101800020304	3,214	3,189	633	20%	164	2	14%
101800020305	4,777	4,140	26	1%	1,009	2	0%
101800020401	15,362	14,822	1,321	9%	2,385	2	5%
101800020402	27,044	25,276	2,897	11%	3,422	2	4%
101800020403	9,561	8,938	1,000	11%	1,234	1	7%
101800020502	615	615	39	6%	115	2	3%
101800020503	12,807	12,194	1,081	9%	1,968	2	6%
101800020504	26,844	25,455	1,413	6%	4,951	2	3%
101800020505	12,479	11,850	632	5%	2,330	2	4%
101800020506	8,495	8,335	816	10%	1,267	2	6%
101800020507	15,046	14,017	578	4%	2,926	2	3%
101800020602	13,058	11,535	691	6%	2,192	2	4%
101800020603	13,057	12,578	638	5%	2,506	2	3%
101800020605	5,661	5,590	15	0%	1,383	2	0%
101800020701	15,800	15,326	1,806	12%	2,025	Not Rated	7%
101800020702	784	777	51	7%	143	2	4%
101800020703	11,405	10,545	767	7%	1,869	2	3%
101800020801	13,732	13,346	1,188	9%	2,149	Not Rated	6%

Subwatershed (HUC 6)	Acres	NFS Acreage	2017 ECA Acres*	Existing ECA Percent of NFS lands	Maximum ECA Equivalent Disturbance Acreage	Existing Watershed Condition Class	ECA Percent-No Action Alt 2039
101800020802	1,358	1,196	122	10%	177	2	6%
101800021101	20,731	18,804	1,858	10%	2,843	2	5%
101800021102	2,849	2,151	285	13%	253	2	7%
101800040101	28,557	27,667	2,386	9%	4,531	2	3%
101800040102	9,974	9,179	1,794	20%	500	2	8%
101800040106	7,301	7,108	1,221	17%	556	Not Rated	7%
101800040109	1,378	1,378	71	5%	273	2	3%
101800040201	39,586	39,506	3,172	8%	6,705	2	4%
101800100201	15,496	15,464	1,022	7%	2,844	2	4%
101800100204	22,321	21,776	2,581	12%	2,863	2	8%
101800100402	12,222	8,113	110	1%	1,918	2	1%
101800100601	22,238	21,304	940	4%	4,386	2	2%
101800100602	13,530	13,141	578	4%	2,707	2	3%
101800100603	30,905	30,800	979	3%	6,721	2	2%
101800100604	3,180	2,576	100	4%	544	2	3%
101800100606	5,544	5,531	506	9%	877	2	5%
101800100801	3,521	3,449	111	3%	752	2	2%
101800100803	2,518	2,496	30	1%	594	2	1%
140500030101	1,931	1,908	148	8%	329	2	5%
140500030103	161	133	1	1%	32	2	1%
140500030104	28,108	25,916	532	2%	5,947	2	2%

Subwatershed (HUC 6)	Acres	NFS Acreage	2017 ECA Acres*	Existing ECA Percent of NFS lands	Maximum ECA Equivalent Disturbance Acreage	Existing Watershed Condition Class	ECA Percent-No Action Alt 2039
140500030106	23,255	19,859	698	4%	4,226	2	3%
140500030108	20,306	18,516	307	2%	4,332	2	1%
140500030109	14,193	12,510	306	2%	2,821	2	2%
140500030110	17,578	13,635	200	1%	3,209	2	1%
140500030201	2,097	2,081	3	0%	518	2	0%
140500030401	9,271	9,261	105	1%	2,210	2	1%
140500030402	5,583	5,572	529	9%	864	2	5%
140500030403	1,444	1,443	181	13%	179	2	8%
140500030404	5,542	5,422	593	11%	763	2	6%
140500030407	27,574	27,246	942	3%	5,869	2	2%
140500030408	6,525	4,988	38	1%	1,209	2	1%
140500030409	16,527	15,775	798	5%	3,146	2	3%

*ECA acres were determined using a GIS model. Assumptions in the model will be validated at the site-specific level. ECA levels will be evaluated and adjusted over time and will be validated for accuracy and adjusted as site-specific treatments are implemented.

APPENDIX C. BEST MANAGEMENT PRACTICES AND DESIGN CRITERIA

The following are Forest Plan standards, guidelines and Forest Service handbook direction that are most relevant and are designed to protect water resources and meet the intent of the Clean Water Act.

HYDROLOGIC FUNCTION:

Manage land treatments to conserve site moisture and to protect long-term stream health from damage by increased runoff. (Water and Aquatic Standard #2; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (1))

- In each watershed containing a 3-rd order and larger stream, limit connected disturbed areas so the total stream network is not expanded by more than 10%. Progress toward zero connected disturbed area as much as practicable. Where it is impossible or impracticable to disconnect a particular connected disturbed area, minimize the areal extent of the individual connected disturbed area as much as practicable. In watersheds that contain stream reaches in diminished stream health class, allow only those actions that will maintain or reduce watershed-scale Connected Disturbed Area. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (1), Design Criteria 1.a)
- Design the size, orientation, and surface roughness (that is. slash and other features that would trap and hold snow on site) of forest openings to prevent snow scour and site desiccation. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (1), Design Criteria 1.b)

Manage land treatments to maintain enough organic ground cover in each activity area to prevent harmful increased runoff. (Water and Aquatic Standard #3; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (2))

- Maintain the organic ground cover of each activity area so that pedestals, rills, and surface runoff from the activity area are not increased. The amount of organic ground cover needed will vary by different ecological types and should be commensurate with the potential of the site. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (2), Design Criteria 1.a)
- Restore the organic ground cover of degraded activity areas within the next plan period, using certified local native plants as practicable; avoid persistent or invasive exotic plants. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (2), Design Criteria 1.b)

RIPARIAN AREAS/WETLANDS:

In the water influence zone next to perennial and intermittent streams, lakes, and wetlands, allow only those actions that maintain or improve long-term stream health and riparian ecosystem

condition. (Water and Aquatic Standard #4; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (3))

- Keep heavy equipment out of streams, swales, and lakes, except to cross at designated points, build crossings, or do restoration work, or if protected by at least 1 foot of packed snow or 2 inches of frozen soil. Keep heavy equipment out of streams during fish spawning, incubation, and emergence periods. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (3), Design Criteria 1.c)
- Ensure at least one-end log suspension in the Water Influence Zone. Fell trees in a way that protects vegetation in the Water Influence Zone from damage. Keep log landings and skid trails out of the Water Influence Zone, including swales. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (3), Design Criteria 1.d)
- Locate new concentrated-use sites outside the Water Influence Zone if practicable and outside riparian areas and wetlands. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (3), Design Criteria 1.e)
- Do not excavate earth material from, or store excavated earth material in, any stream, swale, lake, wetland, or Water Influence Zone. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (3), Design Criteria 1.m)
- Keep ground vehicles out of wetlands unless protected by at least 1 foot of packed snow or 2 inches of frozen soil. Do not disrupt water supply or drainage patterns into wetlands. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (6), Design Criteria 1.a)
- Keep roads and trails out of wetlands unless there is no other practicable alternative. If roads or trails must enter wetlands, use bridges or raised prisms with diffuse drainage to sustain flow patterns. Set crossing bottoms at natural levels of channel beds and wet meadow surfaces. Avoid actions that may dewater or reduce water budgets in wetlands. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (6), Design Criteria 1.b)
- In wet meadows, fens, peatlands, and bog habitats: Prohibit road construction. (Standard #3–BioDiversity: Revised Forest Plan p1-31)

SEDIMENT CONTROL:

Limit roads and other disturbed sites to the minimum feasible number, width and total length consistent with the purpose of specific operation, local topography, and climate. (Soil Standard #1; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (9))

- Construct roads on ridge tops, stable upper slopes, or wide valley terraces if practicable. Stabilize soils onsite. End-haul soil if full bench construction is used. Avoid slopes steeper than 70%.

- Avoid soil-disturbing actions during periods of heavy rain or wet soils. Apply travel restrictions to protect soil and water. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.b)
- Install cross drains to disperse runoff into filter strips and minimize connected disturbed areas. Make cuts, fills, and road surfaces strongly resistant to erosion between each stream crossing and at least the nearest cross drain. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.c)
- Construct roads where practicable, with outslope and rolling grades instead of ditches and culverts. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.d)
- Retain stabilizing vegetation on unstable soils. Avoid new roads or heavy equipment use on unstable or highly erodible soils. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.e)
- Use existing roads unless other options will produce less long-term sediment. Reconstruct for long-term soil and drainage stability. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.f)
- Avoid ground skidding on sustained slopes steeper than 40% and on moderate to severely burned sustained slopes greater than 30%. Conduct logging to disperse runoff as practicable. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.g)
- Designate, construct, and maintain recreational travelways for proper drainage and armor their stream crossings as needed to control sediment. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.h)
- During and following operations on outsloped roads, retain drainage and remove berms on the outside edge except those intentionally constructed for protection of road grade fills. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.i)
- Locate and construct log landings in such a way to minimize the amount of excavation needed and to reduce the potential for soil erosion. Design landings to have proper drainage. After use, treat landings to disperse runoff and prevent surface erosion and encourage revegetation. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (9), Design Criteria 1.j)

Construct roads and other disturbed sites to minimize sediment discharge into streams, lakes and wetlands. (Soil Standard #2; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (10))

- Design all roads, trails and other soil disturbances to the minimum standard for their use and to "roll" with the terrain as feasible. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (10), Design Criteria 1.a)

- Use filter strips, and sediment traps if needed, to keep all sand-sized sediment on the land and disconnect disturbed soil from streams, lakes, and wetlands. Disperse runoff into filter strips. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (10), Design Criteria 1.b)
- Key sediment traps into the ground. Clean them out when 50% full. Remove sediment to a stable, gentle, upland site and revegetate. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (10), Design Criteria 1.c)
- Keep heavy equipment out of filter strips except to do restoration work or build armored stream or lake approaches. Yard logs up out of each filter strip with minimum disturbance of ground cover. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (10), Design Criteria 1.d)
- Design road ditches and cross drains to limit flow to ditch capacity and prevent ditch erosion and failure. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (10), Design Criteria 1.f)

Stabilize and maintain roads and other disturbed sites during and after construction to control erosion. (Soil Standard #3; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (11))

- Do not encroach fills or introduce soil into streams, swales, lakes or wetlands. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (11), Design Criteria 1.a)
- Properly compact fills and keep woody debris out of them. Revegetate cuts and fills upon final shaping to restore ground cover, using certified local native plants as practicable; avoid persistent or invasive exotic plants. Provide sediment control until erosion control is permanent. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (11), Design Criteria 1.b)
- During winter operations, maintain roads as needed to keep the road surface drained during thaws and break-ups. Perform snow removal in such a manner that protects the road and other adjacent resources. Do not use riparian areas, wetlands or streams for snow storage or disposal. Remove snow berms where they result in accumulation or concentration of snowmelt runoff on the road or erodible fill slopes. Install snow berms where such placement will preclude concentration of snowmelt runoff and will serve to rapidly dissipate melt water. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (11), Design Criteria 1.j)

Reclaim roads and other disturbed sites when use end, as needed, to prevent resource damage. (Soil Standard #4; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (12))

- Site-prepare, drain, decompact, revegetate, and close temporary and intermittent use roads and other disturbed sites within one year after use ends. Provide stable drainage that disperses runoff into filter strips and maintains stable fills. Do this work concurrently. Stockpile topsoil

where practicable to be used in site restoration. Use certified local native plants as practicable; avoid persistent or invasive exotic plants. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (12), Design Criteria 1.a)

- Remove all temporary stream crossings (including all fill material in the active channel), restore the channel geometry, and revegetate the channel banks using certified local native plants as practicable; avoid persistent or invasive exotic plants. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (12), Design Criteria 1.b)
- Establish effective ground cover on disturbed sites to prevent accelerated on-site soil loss and sediment delivery to streams. Restore ground cover using certified native plants as practicable to meet revegetation objectives. Avoid persistent or invasive exotic plants. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (12), Design Criteria 1.d)

SOIL QUALITY:

Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area. (Soil Standard #5; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (13))

- Restrict roads, landings, skid trails, concentrated-use sites, and similar soil disturbances to designated sites. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (13), Design Criteria 1.a)
- Operate heavy equipment for land treatments only when soil moisture is below the plastic limit, or protected by at least 1 foot of packed snow or 2 inches of frozen soil. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (13), Design Criteria 1.a)
- Conduct prescribed fires to minimize the residence time on the soil while meeting the burn objectives. This is usually done when the soil and duff are moist. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (13), Design Criteria 1.c)

WATER PURITY:

Place new sources of chemical and pathogenic pollutants where such pollutants will not reach surface or ground water. (Water and Aquatic #10; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (15))

- Locate pack and riding stock sites (for example corrals and loading areas), sanitary sites, and well drill-pads outside the water influence zone (WIZ). (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (15), Design Criteria 1.a)
- Locate vehicle service and fuel areas, chemical storage and use areas, and waste dumps and areas on gentle upland sites. Mix, load, and clean on gentle upland sites. Dispose of chemicals and containers in State-certified disposal areas. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (15), Design Criteria 1.b)

- Locate temporary labor, spike, logging and fire camps such that surface and subsurface water resources are protected. Consideration should be given to disposal of human waste, wastewater and garbage and other solid wastes. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (15), Design Criteria 1.c)

Apply runoff controls to disconnect new pollutant sources from surface and groundwater. (Water and Aquatic #11; Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2, Management Measure (16))

- Install contour berms and trenches around vehicle service and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills. Use liners as needed to prevent seepage to ground water. Prepare Spill Prevention Control and Countermeasure Plan per the requirements of 40 CFR 112. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (16), Design Criteria 1.a)
- Report spills and take appropriate clean-up action in accordance with applicable state and federal laws, rules and regulations. Contaminated soil and other material shall be removed from NFS lands and disposed of in a manner according to state and federal laws, rules and regulations. (Watershed Conservation Practices handbook, R2 Amendment 2509.25-2006-2 Management Measure (16), Design Criteria 1.f)

APPENDIX D - DISCLOSURE OF EFFECTS ON HYDROLOGY AT THE ACCOUNTING UNIT SCALE

Accounting Unit	WIZ acres within accounting unit	Potential miles of temporary roads within accounting unit[1]	Potential Stand Initiation and Intermediate Harvest Acres within Water Influence Zone[2]
Battle Pass	6033	28	1556
Big Blackhall	10058	122	3083
Bow Kettle	11473	93	2416
Cedar Brush	10444	100	2870
Fox Wood	14001	219	4982
French Douglas	10854	105	2519
Green Hog	8883	70	1975
Jack Savery	7548	149	4511
North Corner	7251	55	1753
Owen Sheep	4031	14	1463
Pelton Platte	6644	46	1270
Rock Morgan	8080	72	1918
Sandy Battle	9339	144	4534
West French	8382	137	3343

[1] Total for project limited to 600 miles – to be allocated during implementation. This represents the estimate miles of road necessary to harvest the Treatment Opportunity Areas that include harvest and do not preclude temporary road constructions. Assume one mile of temporary road per 334 acres of harvest.

[2] Represents sum of mechanical treatments in accounting unit assuming all 260,000 acres of stand initiation and intermediate treatment occur multiplied by 6.49%, the Forest Plan period amount of harvest that has occurred in the WIZ. Actual harvest in WIZ likely to be less as all mechanical treatment opportunity areas in an accounting unit are unlikely to be treated.